NORTHEAST FLOOD STUDIES

INTERIM REPORT
ON
REVIEW OF SURVEY

SAXONVILLE LOCAL PROTECTION

SUDBURY RIVER

MERRIMACK RIVER BASIN

FRAMINGHAM, MASSACHUSETTS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

FEBRUARY 1965

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Corps of Engineers, Waltham, Mass.

26 February 1965

SYLLABUS

The Division Engineer finds that there is need for modification of the existing flood control plan for the Merrimack River Basin. He finds that the Sudbury River, a tributary of the Concord River, causes major damages along its water course, particularly in the Saxonville section of the Town of Framingham, Massachusetts. He concludes that flood control in the report area is necessary and warranted. The Division Engineer recommends construction of a local protection project consisting of dikes, floodwalls, a pumping station, highway and railroad gate closures, channel improvement and other appurtenant work, at Saxonville in Framingham at an estimated total first cost of $1,490,000. He further recommends that local interests be required to:

a. Provide without cost to the United States, all lands, easements, and rights-of-way necessary for the construction and operation of the project, including lands for spoil disposal areas, pumping station, and drainage systems;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Provide without cost to the United States all alterations and replacements of existing utilities currently estimated at $5,000;

e. Prescribe and enforce regulations:

(1) To prevent encroachment on the improved channel

(2) To prevent further encroachment on the unimproved channel;

f. Prohibit encroachment on ponding areas and if the capacity of these areas is impaired, promptly provide substitute ponding capacity or equivalent pumping capacity without cost to the United States.

The Federal first cost of the project is currently estimated at $1,300,000; the first cost to local interests for lands and relocations is currently estimated at $190,000.

R 4/16/65

INTERIM REPORT ON REVIEW OF SURVEY
FOR FLOOD CONTROL
MERRIMACK RIVER BASIN
SAXONVILLE LOCAL PROTECTION
SUDBURY RIVER, FRAMINGHAM, MASSACHUSETTS

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B	Flood Losses and Benefits
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D	Letters of Comment and Concurrence

ATTACHMENT

Information called for by Senate Resolution 148 (follows Appendix D)

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASS. 02154

DRESS REPLY TO:
VISION ENGINEER

FER TO FILE NO.
NEDED-D

26 February 1965

SUBJECT: Interim Report on Review of Survey for Flood Control, Merrimack River Basin, Saxonville Local Protection, Sudbury River, Framingham, Massachusetts

TO: Chief of Engineers
ATTN: ENGCW-PD

SECTION I

AUTHORITY

1. AUTHORIZING RESOLUTION

This report is submitted in partial response to authorities contained in Resolution by the Committee on Public Works of the United States Senate, adopted 14 September 1955 and 9 February 1961 which are described in part or quoted respectively as follows:

> "That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review previous reports on the Merrimack River, Massachusetts .... in the area affected by the hurricane flood of August 1955, to determine the need for modification of the recommendations in such previous reports and the advisability of adopting further improvements for flood control and allied purposes in view of the heavy damages and loss of life caused by such floods."

> "That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved 13 June 1902, be, and is hereby requested to review the reports of the Chief of Engineers on the Merrimack River, New Hampshire and Massachusetts, published as House Document Numbered 689, Seventy-fifth Congress, third session, and other reports, with a view to determining the need for modification of the recommendations contained in such reports, and the advisability of adopting further improvements for flood control and allied purposes in view of the heavy damages and loss of life caused by recent severe storms in the Merrimack River Basin."

R 4/16/65

SECTION II

EXTENT OF INVESTIGATION

2. SCOPE OF REPORT

This interim report of survey scope comprises a review of the flood problems caused by the Sudbury River in the Saxonville section of Framingham, Massachusetts. It is one of a series of reports which, when completed, will constitute a review of the needs of the New England area with respect to flood control and allied water uses. Flood problems and solutions considered for the remainder of the Merrimack River Basin are covered in other reports. The purpose of this report is to determine the advisability and economic feasibility of flood control im-improvements in the area under consideration. The area covered by this report and the projects authorized as a result of previous reports are shown on Plate No. 1.

3. SCOPE OF STUDIES

a. Surveys and studies. U. S. Army Map Service, U. S. Geological Survey, local maps and plane table topographic surveys of the project area were used in the study. Subsurface investigations consisted of field reconnaissance by geologists and soils engineers, 15 drive sample borings, 6 hand auger borings, 35 hand probings, 1 test pit and review of 2 previous test borings for a bridge foundation in the area. Flood damage surveys made in 1961 and 1964 consisted of field examinations of the project area and personal interviews with municipal officials, officers of industrial and commercial concerns, and private individuals experiencing losses. In addition, surveys of experienced flood damages of the Concord River and its tributaries made after the flood of August 1955 by the U. S. Department of Agriculture, Soil Conservation Service were reviewed. Office studies consisted of hydrologic and hydraulic analyses and estimates of quantities and costs of major items of construction, utility relocations and real estate required for the project.

b. Consultations with interested parties. A public hearing was held in Lowell, Massachusetts on 30 November 1960, at which time interested parties were afforded an opportunity to express their views concerning improvements desired in connection with flood control and related water resources development in the Lower Merrimack River Basin in Massachusetts.

On 15 January 1963, a public meeting was held by the Town of Framingham, Massachusetts, at which time interested local people expressed a desire for flood protection. The meeting was attended by representatives of the Division Engineer. A special town meeting was held in Framingham on 28 March 1963 at which time the Town authorized the Board of Selectmen to continue to participate in the local flood control project and to submit assurances of local cooperation. A synopsis of the hearing and meetingsis given in Section VII. Meetings also have been held with the U. S. Department of Agriculture, Soil Conservation Service, the Massachusetts Water Resources Commission, State and local officials, and with private individuals.

c. Field reconnaissance. Field reconnaissance of the problem area has been made by the Division Engineer and representatives of his office.

SECTION III

PRIOR REPORTS

4. PRIOR REPORTS

There are no prior reports concerning local protection in the Saxonville area of Framingham, Massachusetts. Flood control in the Merrimack River Basin has been considered in the reports noted in the succeeding paragraphs.

5. PUBLISHED REPORTS

a. "308" Report. A report dated 1 December 1930 and printed as House Document No. 649, 71st Congress, 3rd Session, considered the needs for navigation, water power, flood control and irrigation on the Merrimack River in New Hampshire and Massachusetts. The report concluded that improvements were not economically warranted at that time.

b. 1938 Report. A report by the Chief of Engineers dated 18 May 1938 and printed as House Document No. 689, 75th Congress, 3rd Session, presented a plan for flood control of the Merrimack River Basin. Based on report findings, the 1938 Flood Control Act modified the Flood Control Act of 1936 and authorized the construction of a system of flood control reservoirs and related flood control works which may be found justified by the Chief of Engineers. The present constructed reservoir system consists of four dams located in New Hampshire: Franklin Falls; Blackwater; Edward MacDowell; and Hopkinton-Everett. Local protection works are completed at Lincoln and Nashua, New Hampshire and Lowell, Haverhill and Fitchburg, Massachusetts.

c. NENYIAC Report. Flood control and allied water uses were also considered in Part 2, Chapter XV, "Merrimack River Basin," of The Resources of the New England-New York Region. This comprehensive report inventoried the resources of the New England-New York area and contained a master plan to be used as a guide for the regional planning, development, conservation and use of land, water and related resources of the region. Prepared by the New England-New York Inter-Agency Committee, the report was submitted to the President of the United States by the Secretary of the Army on April 27, 1956. Part 1 and Chapter I of Part 2 are printed as Senate Document No. 14, 85th Congress, 1st Session.

6. OTHER STUDIES UNDERWAY

Studies are presently underway for other portions of the Merrimack River Basin.

SECTION IV

DESCRIPTION

7. LOCATION

The village of Saxonville is located in the northeasterly part of the Town of Framingham, Middlesex County, Massachusetts and is situated on the Sudbury River approximately 15 miles upstream from its confluence with the Assabet River which together form the Concord River. Framingham, consisting of a land area of 25.7 square miles, is located approximately 20 miles west of Boston and about 20 miles east of Worcester, Massachusetts. The project area, located along the left bank of the Sudbury River in the village of Saxonville, extends from Saxonville Pond at Central Street to Danforth Street, a total length of approximately 3,800 feet. Plate No. 1 shows the relative location of Saxonville in the Merrimack River Basin and a general plan of the project area is shown on Plate No. 2.

8. TOPOGRAPHY

The densely settled portion of the village of Saxonville occupies approximately 35 acres of low land inclosed by a U-shaped bend of the Sudbury River. The land rises gradually from south to north with elevations ranging from less than 118 feet m.s.l. near the river edge to over 150 feet above m.s.l. at the intersection of Danforth and Concord Streets. On the opposite bank of the river the ground is generally high except in the vicinity of Cochituate Brook which flows into the Sudbury River just beyond the point where the U-shaped bend of the river makes its turn to the north.

9. GEOLOGY

Saxonville lies near the inland edge of the seaboard lowland, between the central Massachusetts upland and the Boston Basin coastal lowland. The site is drained to the northeast by the Sudbury River and is separated from the Boston Basin which drains eastward, by a narrow northeast-trending upland of igneous rocks known as the Fells Upland. The gradient is very flat downstream of the project area where the river traverses a wide flood plan flanked by glacial lake terrace deposits. The gradient is strikingly greater toward the river source which lies in rock and till hills flanking the central uplands. Bedrock at the site consists of a contorted chlorite schist member of the Marlboro Formation. Overburden consists of thin flood plain deposits, including some organic silt, terrace sands and gravels, and glacial till which flanks a few nearby hills and lies adjacent to the bedrock which is exposed infrequently in the project vicinity.

10. STREAM CHARACTERISTICS

a. Main Stream. The Sudbury River drains a total area of 163 square miles and originates at Cedar Swamp Pond in Westborough, Massachusetts. It flows easterly through the Towns of Hopkinton and Ashland and then continues in a northerly direction through the Towns of Framingham, Wayland, Sudbury, Lincoln and Concord to its confluence with the Assabet River, forming the Concord River. The Sudbury River with headwaters at an elevation of about 274 feet above m.s.l. meanders and flows through extensive marshlands, ponds and a water supply reservoir system. The river falls about 164 feet in the distance of about 30 miles to its confluence. Starting at the project area just downstream from the Saxonville Pond Dam to its confluence, the topography in this reach of the river is flat with a fall of about 10 feet in a distance of approximately 15 miles.

b. Tributaries. Cochituate Brook is the only tributary stream of any significance in the local protection project area. This stream has a drainage area of about 20 square miles of which 17.4 square miles is controlled by the outlet at Lake Cochituate. The reach of Cochituate Brook from its confluence with the Sudbury River to the outlet at Lake Cochituate has a drainage area of 2.6 square miles and is 1-3/4 miles long.

11. AREA MAPS

The Saxonville-Framingham area is shown on U. S. Army Map Service quadrangle, Framingham, Massachusetts, to a scale of 1:25,000 with 10-foot contour intervals and on U. S. Geological Survey Map, Framingham, Massachusetts to a scale of 1: 24,000 with 10-foot contour intervals.

12. WEATHER AND FLOODS

The Sudbury River watershed is located within the influence of constant conflicts between cool dry air masses moving in from polar regions and moisture-bearing tropical, marine air from the south and east. This results in a succession of alternate low pressure or cyclonic disturbances, accompanied by snow or rain and high pressure or anticyclonic disturbances characterized by cool, dry conditions. The average annual temperature in the Framingham area is about 49°F. Recorded temperature extremes within the watershed have varied from occasional highs slightly in excess of 100°F to infrequent lows below minus 25°F.

The mean annual precipitation over the Framingham area is about 44 inches uniformly distributed throughout the year. The maximum monthly precipitation recorded at Framingham, Massachusetts, was 15.69 inches occurring in August 1955. The average annual snowfall in the project area is about 49 inches. In the tributary headwater areas of the Sudbury River watershed where the snowfall is greatest, the snow cover often remains until spring. The melting of this snow cover during spring thaws, especially if accompanied by heavy rainfall, is one of the principal causes of floods in the Sudbury River basin such as the flood of March 1936. Major floods in the area have resulted from summer and fall storms also, such as the record flood of August 1955 and the flood of September 1954. In addition, local thunderstorms can cause serious flash floods on the smaller streams in the watershed.

13. POPULATION

The population of the Town of Framingham in 1960, based on the U. S. Bureau of the Census figures, was 44,526. This represents a population increase of about 92% since 1940 making it one of the fastest growing towns in the Commonwealth of Massachusetts. The densely populated village of Saxonville forms a part of Framingham.

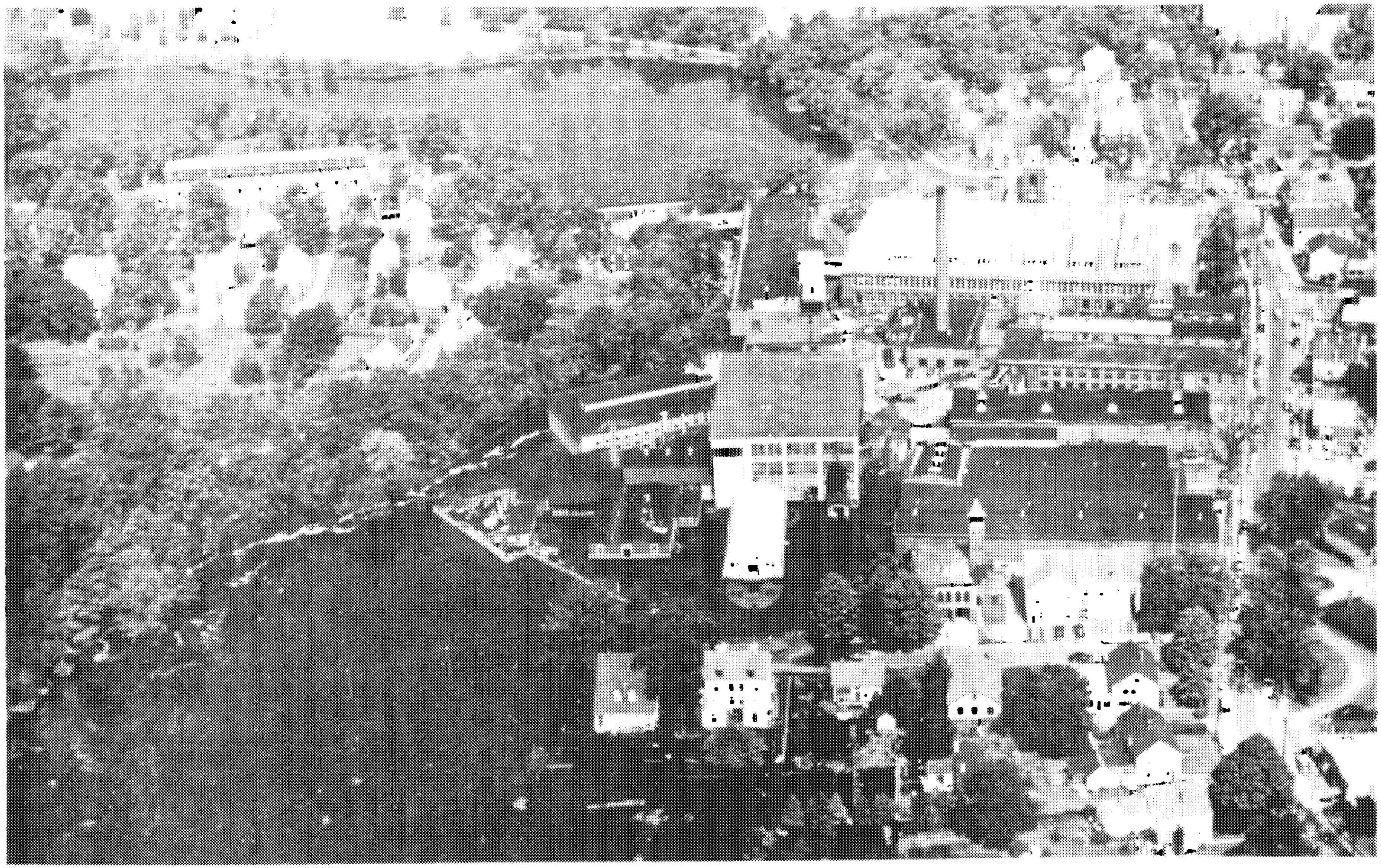
14. TRANSPORTATION

The Framingham area is served by a network of modern highways and secondary roads. The four principal routes are Interstate Highway No. 90 and State Highways No. 9 and 135 which pass through Framingham in an east-west direction, and connect with State Highway No. 126 which runs north and south. The main lines of the New York, New Haven and Hartford Railroad and the New York Central Railroad provide passenger and freight service for the Framingham area. The Logan International Airport located about 20 miles east of Framingham and major bus lines service the Framingham area.

15. EXTENT AND CHARACTER OF FLOODED AREA

Industrial and commercial activity in the village of Saxonville is concentrated along the stretch of the Sudbury River which runs between Central Street and Danforth Street. The river in this reach follows an irregular "U" shaped course flowing generally from Central Street, first southerly then easterly and then northerly. Approximately 60 acres of urban property on both sides of the stream are subject to flooding by the Standard Project Flood. The densely settled portion of the village is built on low-lying land on the left bank inclosed by the river bend; on the opposite bank newer facilities reflect continuing growth in the area.

The maximum flood of record (August 1955) inundated 22 acres of the left bank area with depths of water up to 8 feet. Damage was sustained by 9 buildings of the Roxbury Carpet Company; 7 commercial establishments; 23 residential properties, some multi-family; and 3 public buildings. On the right bank of the river, the ground is generally high except in the vicinity of Cochituate Brook which flows into the Sudbury River just beyond the point where the river swings to the north. In this area some 36 acres of land are subject to flooding, although not to the depth of flooding experienced on the left bank. There were 13 improved properties, mainly commercial, at the time of the record flood. Currently, 22 improved properties occupy this area. Total



August 1955 Flood. Industrial, commercial and residential properties along the Sudbury River. Saxonville Pond and Central Street at top of photo and Concord Street at the right.

property valuation for both areas including inventories and machinery is estimated to be $3,400,000 with over $3,000,000 being on the left bank.

SECTION V

FLOOD DAMAGES

16. EXPERIENCED LOSSES

From data obtained by personnel of the Soil Conservation Service of the U. S. Department of Agriculture, it is estimated that the experienced direct physical loss in the study areas in the record flood of August 1955 was $206,000. It is estimated that total losses in the flood of record were in excess of $500,000.

17. RECURRING LOSSES

Flood damage surveys were conducted in August 1961 and reviewed in 1964. Based on these surveys, it is estimated that a recurrence of the record flood levels of August 1955 would cause losses estimated at $1,040,000 under current economic conditions. All but $145,000 of this loss would be to improvements situated on the left bank.

18. ANNUAL LOSSES

Estimated recurring losses for various stages of flooding were correlated with stage frequency data to develop damage frequency relationships to determine annual losses. Annual losses amount to $74,000 under current economic conditions in the project area on the left bank.

19. TRENDS OF DEVELOPMENT

The village of Saxonville is located in the northeast corner of the Town of Framingham, one of the fastest growing towns in Massachusetts. Located on the western fringe of the Boston SMSA and included therein, the town had a population growth, percentage-wise, of 21% in the 1940-1950 decade followed by a growth of 58.5% in the 1950-1960 period. The growth is continuing. While some of the population growth reflects the town's popularity as a bedroom community for the core city of Boston, it has had an impressive growth in industrial and commercial plants over the past two decades which also contributed to its population increase. While much of the land on the right bank of the river is already committed to buildings, access and circulation, there is some

AUGUST 1955 FLOOD - SUDBURY RIVER AT SAXONVILLE

Roxbury Carpet Company building on left bank. Note flood levels approaching window sills.

Picture taken after flood waters started to recede. Industrial buildings on left bank.

land available for development which will be put to use in the future increasing the potential flood losses in the area. On the left bank, which is almost completely built over, the expected changes will reflect a gradual conversion from present obsolete residential property to commercial property. In addition one six-acre parcel of idle land is expected to be utilized as industrial property. An adjustment was made in the annual losses to reflect the future growth for the six-acre tract.

SECTION VI

IMPROVEMENTS BY FEDERAL AND NON-FEDERAL AGENCIES

20. GENERAL

No projects for flood control in Framingham have been constructed by the Corps of Engineers or other Federal and non-Federal agencies.

21. SOIL CONSERVATION SERVICE

The Soil Conservation Service of the U. S. Department of Agriculture has an approved work plan for flood control in the SuAsCo (Sudbury, Assabet and Concord Rivers) basin which would reduce flood damages by land treatment measures, construction of floodwater retarding structures in the Assabet River basin, and drawdown and reregulation of existing water supply reservoirs on the upper reaches of the Sudbury River. Three of the floodwater retarding structures have been completed, one is currently under construction, and two others are in the process of being designed. This SCS approved work plan would not provide any significant reduction in flood stages at the Saxonville project area during major floods.

SECTION VII

IMPROVEMENTS DESIRED

22. PUBLIC HEARINGS

In order to ascertain the views of those interested in flood control and allied measures on the Merrimack River and its tributaries in the area affected by the hurricane flood of August 1955, a public hearing was held in Lowell, Massachusetts, on 30 November 1960. On 15 January and 28 March 1963, public meetings were sponsored and conducted by the Town of Framingham, Massachusetts, to afford interested local people an opportunity to express their views regarding the flood protection for the Saxonville area.

23. LOWELL HEARING

The Lowell public hearing was attended by about 35 persons including representatives of Federal, State and Municipal Governments, industrial interests, civic organizations and individuals concerned. Improvements requested included dikes and floodwalls supplemented by reservoirs on the tributary streams of the Merrimack River and protection of localized flood prone areas. Testimony and remarks were predominantly in favor of flood control improvements in the lower Merrimack River Basin.

24. FRAMINGHAM MEETINGS

The meeting held on 15 January 1963 was attended by about 50 people, of which 9 were Town Meeting Members and 12 were residents directly affected by the project. The plan of protection received the general approval of those present. The second meeting held on 28 March 1963 was attended by about 200 people, of which 150 were Town Meeting Members. An overwhelming majority vote in favor of the flood control project was received at this meeting.

SECTION VIII

FLOOD PROBLEMS AND SOLUTIONS CONSIDERED

25. FLOOD PROBLEMS

The Saxonville report area is susceptible to floods caused by rain, melting snow, and a combination of both. The sluggish characteristics of the Sudbury River produced by its low stream gradient and flat marshy topography, provide natural storage for floodwaters causing backwater flood conditions. The major floods of recent years have occurred as a result of hurricane-type storms. The flood of August 1955 which was approximately 40 percent greater than any other flood of record resulted from intense rainfall accompanying hurricane "Diane". Other major floods occurred in March 1936, July 1938 and September 1954. The August 1955 flood of record inundated 22 acres of land on the left bank of the Sudbury River in the project area with depths of water up to 8 feet, and 36 acres of land on the right bank. It is estimated that approximately 28 acres would be inundated on the left bank in the event of a Standard Project Flood. The limits of flooding are shown on Plate No. 2.

26. SOLUTIONS CONSIDERED

Alternative methods of solving the flood problems were considered including raising the existing Saxonville Pond Dam, channel improvements, diversion and relocation of the Sudbury River, flood plain zoning, and evacuation and resettlement. Raising the existing Saxonville Pond Dam to provide flood control storage was found to be economically unsound due to the high cost of real estate and extensive development in the upstream area. Diversion and relocation of the river was found to entail inordinately high construction costs. Evacuation of the flood plain was also rejected as impracticable due to the high value of improved real estate. Flood plain zoning is possible in limited areas but appears impracticable in the intensely occupied area in Saxonville. These methods are described in succeeding paragraphs. Construction of dikes, flood walls and channel improvements was found to be the most practical solution to the flood problems in the Saxonville area.

27. RELATED WATER RESOURCE DEVELOPMENTS

Related water resource development would not be feasible in conjunction with the selected plan.

SECTION IX

FLOOD CONTROL PLANS

28. GENERAL

The plan shown on Plate No. 2 is designed to prevent the flooding of about 16 acres of industrial, commercial, residential and unimproved land along the left bank of the Sudbury River in a recurrence of the August 1955 flood, and 22 acres or about 80 percent of the area that would be flooded in an occurrence of a Standard Project Flood which would produce a discharge about 25 percent greater than the 1955 flood.

29. DESCRIPTION OF PLAN

a. Description. The local protection works for Saxonville would be located along the left bank of the Sudbury River, extending from the Saxonville Pond Dam at Central Street to the Danforth Street bridge, a distance of about 3,800 feet. The project would include construction of 2,900 feet of earth dikes, 750 feet of concrete floodwalls, a vehicular flood gate, a railroad stoplog structure, a pumping station and appurtenant structures. A section of the river channel between the New York Central Railroad bridge and the Danforth Street bridge would be straightened for about 1,200 feet in length with a 60-foot bottom width.

Dikes and walls would have heights above the stream bed varying from 19 to 22 feet. A vehicular flood gate would be required at Concord Street and a stoplog structure at the railroad spur crossing. A pumping station having a discharge capacity of 16,000 gallons per minute would be provided to handle local interior drainage including industrial waste water and seepage during flood periods. Construction of the project would necessitate the taking of about 12 acres of land, 1 residential unit and 4 storage sheds, and in addition, would make available for industrial use 6 acres of currently unproductive flood-prone land.

b. Hydrologic and Hydraulic Considerations. The project would be designed to protect against the standard project flood flow of 5,800 cubic feet per second downstream of Cochituate Brook and 5,000 cubic feet per second upstream of Cochituate Brook. The standard project flood discharges are about 25 percent greater than the maximum flood of record.

c. Degree of Protection. This project would provide protection against the standard project flood for about 22 acres in the village of Saxonville.

30. PROVISIONS AGAINST ENCROACHMENT

Provisions against encroachment on the improved channels, existing channel and the existing waterway areas under bridges would be a local responsibility. The channel would be maintained and kept free of obstructions and debris by local interests.

31. OTHER PLANS STUDIED

a. Flood Control Reservoirs. Other methods of solving the flood problems in the Saxonville area were considered. The prevalence of topographic features providing natural flood storage minimizes the effectiveness of possible flood control reservoirs. Consideration was given to raising the existing Saxonville Pond Dam to provide flood control storage. Studies indicated it would be necessary to raise the dam about 24 feet to provide a flood storage capacity of 4.5 inches of runoff from the 86 square mile drainage area. Such storage would inundate

Cushing State Hospital, the Framingham High School, a large new shopping center, and extensive high class residential and commercial areas. Due to such extensive dislocation, no further consideration was given to this plan.

b. Right Bank Protection. At the request of local interests, preliminary studies were made to include flood protection of the flood-prone areas on the right side of the Sudbury River, in addition to the left bank project described herein. Three alternate plans were studied for protecting the areas upstream and downstream along the right bank in the vicinity of Concord Street and Cochituate Brook. The construction plans included earth dikes, concrete floodwalls, highway and railroad gate closures, pumping station and appurtenant structures. With much of the land in this flood-prone area undeveloped at the present time, benefits attributable to the improvements studied were evaluated to total about 20 percent of the cost.

c. Alternative Alignments. Comparison studies were made of the selected plan with alternative alignments of the earth dikes upstream and downstream of Concord Street. West (upstream) of Concord Street, two alternative alignments would cross the vacant land within the curve of the "U" formed by the river, each successively inclosing less of the vacant land, part of which is now used as a parking lot. To the east (downstream) of the Concord Street crossing, two alternative alignments were also considered. Combinations of these alignments with that of the selected plan provided a total of nine alternative plans studied. The selected plan provides optimum protection both area-wise and benefit-wise and would protect the entire flood-prone area along the left bank of the Sudbury River between Central Street and Danforth Street, and permit expansion in currently vacant land. The added benefits for this plan over those of each of the alternatives are equal to or greater than the added costs.

d. Zoning Restrictions. Flood plain restrictive zoning would be a completely uneconomic solution to the Saxonville flood problems on the left bank of the river because of the high value of existing improvements. Zoning to control development along the right bank of the river appears possible. State enabling legislation permits the town to consider the possibility of some form of zoning to control future development in this area. Evacuation of existing developments within the flood plain appears unreasonable since the cost would be far in excess of the cost of flood protection and would cause major dislocation of the local economy.

e. Tunnel Diversion. Consideration was given to diverting the water from Saxonville Pond to the Sudbury River downstream from Danforth Street. A diversion tunnel approximately 1,000 feet in length would be required. The tunnel would have a 17-foot diameter with a concrete intake structure at Saxonville Pond and a stilling basin at the outlet to the Sudbury River. A dam would be required across the Sudbury River to prevent backwater flooding of the protected area. The dam would be about 300 feet in length and have a top width of 12 feet and a maximum height of 32 feet above the stream bed. A pumping station would be required having a discharge capacity to handle local interior drainage from 2.6 square miles of area and to pump the flow from Cochituate Brook over the dam during flood periods. Flood gates would be required in the dam to pass normal flows. The existing outlet for Lake Cochituate would be modified to provide flood control storage. A flood control outlet would be constructed at the north end of Lake Cochituate to divert flows to the Sudbury River downstream of the project area. Although this plan would afford flood protection for the areas on both sides of the Sudbury River, it was estimated to cost over $4,000,000. It is considerably more costly than the selected plan without providing a commensurate increase in benefits.

SECTION X

ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES

32. FIRST COSTS

Unit prices used in estimating construction costs are based on average bid prices for similar work in the same general region, adjusted to the June 1964 price level. Valuations of property are based on information from local officials and reflect values in recent sales in the area. All costs include an allowance for contingencies. The costs for engineering and overhead are based on knowledge of the site and experience on similar projects. A summary of first costs for the selected plan is given in Table 1.

33. ANNUAL CHARGES

Average annual costs, also summarized in Table 1, are based on an interest rate of 3-1/8 percent. Investment costs are amortized over the 50-year assumed economic life of the project. Allowances are made for costs of maintenance and operation and for interim replacement of equipment having an estimated life of less than 50 years.

TABLE 1

SUMMARY OF FIRST COSTS AND ANNUAL CHARGES
SAXONVILLE LOCAL PROTECTION
(June 1964 Price Level)

First Costs		Recommended Plan
Federal		
Channels and Canals		$ 29,000
Levees and Flood Walls		
Site Preparation	$12,000	
Stream Control	24,000	
Land Dikes	350,000	
Flood Walls	367,000	
Vehicular Gate	60,000	
Stoplog Structure	35,000	
Drainage	82,000	
		930,000
Pumping Plants		120,000
Total Direct Federal Costs		$1,079,000
Engineering and Design		135,000(1)
Supervision and Administration		86,000
Total Federal Cost		$1,300,000
Non-Federal		
Lands and Damages		$ 185,000
Relocations and Utilities		5,000
Total Non-Federal Costs		$ 190,000
TOTAL FIRST COSTS		$1,490,000
Annual Charges		
Interest		$ 46,500
Amortization		12,700
Maintenance and Operation		2,500
Interim Replacements		1,500
Loss of Productivity of Land		1,500
Total Annual Charges		$ 64,700

(1) Does not include preauthorization costs of $30,000.

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SECTION XI

ECONOMIC ANALYSIS

34. FLOOD DAMAGE PREVENTION BENEFITS

Average annual flood damage prevention benefits were derived as the difference between annual losses under conditions in Saxonville without flood protection and those that would result under conditions expected over the project life after construction of protective works to Standard Project Flood heights. Average annual benefits so derived amount to $73,300 on the left bank of the Sudbury River in the study area.

35. TANGIBLE BENEFITS

Total tangible average annual benefits to the selected project amount to $73,300.

36. INTANGIBLE BENEFITS

In addition to the tangible benefits of providing the protection, important intangible benefits would accrue to the project through the reduction of the threat to life and of the potential danger of disease from polluted floodwaters.

37. PROJECT FORMULATION

A summary of the estimated annual charges, the estimated annual benefits and the ratio of benefits to charges for the plan of improvement considered for Saxonville is shown in Table 2.

TABLE 2

SUMMARY OF COSTS AND BENEFITS
SAXONVILLE LOCAL PROTECTION
(June 1964 Price Level)

First Costs	Recommended Plan
Federal	$1,300,000
Non-Federal	190,000
Total First Costs	$1,490,000
Annual Charges	
Federal	$ 51,700
Non-Federal	13,000
Total Annual Charges	$ 64,700
Annual Benefits	$ 73,300
Benefit-Cost Ratio	1.1 to 1

SECTION XII

PROPOSED LOCAL COOPERATION

38. GENERAL

There is need and desire for flood protection in the Saxonville part of the town of Framingham. State and Town officials have indicated a willingness and ability to fulfull the conditions of local cooperation. In accordance with Section 3 of the 1936 Flood Control Act, as amended, local interests would be required to provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction and operation of the local protection project; hold and save the United States free from damages due to the construction works; and maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army.

Under the requirements of lands, easements, and rights-of-way, acquisition of land rights required for spoil disposal areas, pumping stations, storage ponds, and collector ditches, would also be the responsibility of local interests, as would the necessary modification and relocation of the municipal sewage system and minor utility relocations.

Local interests would also be required to prevent encroachment on the improved channel and ponding areas and prevent further encroachment on the unimproved channel.

SECTION XIII

COORDINATION WITH OTHER AGENCIES

39. GENERAL

Plans for local protection at Saxonville have been reviewed by Federal, State and local agencies concerned, including the Soil Conservation Service of the U. S. Department of Agriculture, the Fish and Wildlife Service of the U. S. Department of the Interior, the Massachusetts Water Resources Commission and officials of the town of Framingham.

The Regional Director of the Bureau of Sports Fisheries, Fish and Wildlife Service, Department of the Interior, has investigated the fish and wildlife aspects of the project and concludes that it will have no significant detrimental effect on the fish and wildlife resources nor are there any opportunities to enhance such resources.

SECTION XIV

DISCUSSION

40. FLOOD CONDITIONS

Industrial, commercial and residential properties have suffered damages in four major floods in the past 27 years, resulting in disruption of a portion of the Town's economy, and highlighting the need for protection for the Saxonville area. The flood of August 1955, the most damaging flood ever experienced in the Saxonville area occurred when hurricane "Diane" dropped 13 inches of rainfall inundating 16 acres of the proposed protected area with depths of water up to 8 feet. A recurrence of the August 1955 flood levels would cause losses in the project area estimated at about $900,000. In the event of the standard project flood, losses would amount to $1,465,000 in the project area under today's economic condition.

41. METHODS CONSIDERED

Other solutions of the flood problem were considered, including flood water impoundments, improvement of channel, zoning of flood plains and diversion of the Sudbury River. These methods were found to be economically infeasible at this time. The method found worthy of detailed study consists of dikes, floodwalls, gate closures and other appurtenant works for the village of Saxonville.

Additional information on recommended and alternative projects called for by Senate Resolution 148, 85th Congress, 1st Session, adopted 28 January 1958, is contained in an Attachment to this report.

SECTION XV

CONCLUSIONS AND RECOMMENDATIONS

42. CONCLUSIONS

As a result of studies made for this report, it is concluded that construction of a local protection project in the Saxonville area essentially as described in this report is warranted. The proposed project would provide a high degree of protection, is economically justified, and meets the desires of local interests.

43. RECOMMENDATIONS

It is recommended that the construction of a local protection project on the Sudbury River in the village of Saxonville at Framingham, Massachusetts be authorized essentially as described in this report with such modifications thereof as, in the discretion of the Chief of Engineers, may be advisable at the time of detailed design studies, at a total estimated cost of $1,490,000 for construction; provided that, prior to construction, local interests give assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction and operation of the project, including lands for spoil disposal areas, pumping station, and drainage systems;

b. Hold and save the United States free from damages due to the construction works;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Provide without cost to the United States all alterations and replacements of existing utilities, including bridges, highways, sewers, and railroad modifications and relocations other than bridges and bridge approaches, which may be required for the construction of the project; utility relocations are currently estimated to cost $5,000;

e. Prescribe and enforce regulations:

(1) To prevent encroachment on the improved channel

(2) To prevent further encroachment on the unimproved channel;

f. Prohibit encroachment on ponding areas and if the capacity of these areas is impaired, promptly provide substitute ponding capacity or equivalent pumping capacity without cost to the United States.

First costs to local interests are estimated at $190,000. The Federal first costs of the project, exclusive of pre-authorization costs, are estimated at $1.3 million. Annual costs for maintenance and operation of the project, which are items of local responsibility, are estimated at $4,000 including $1,500 for major replacements.

Attachments
2 Plates
4 Appendices
S-148 Attachment

E. J. RIBBS
Colonel, Corps of Engineers
Acting Division Engineer

R 4/16/65

ACKNOWLEDGEMENTS AND IDENTIFICATION OF PERSONNEL

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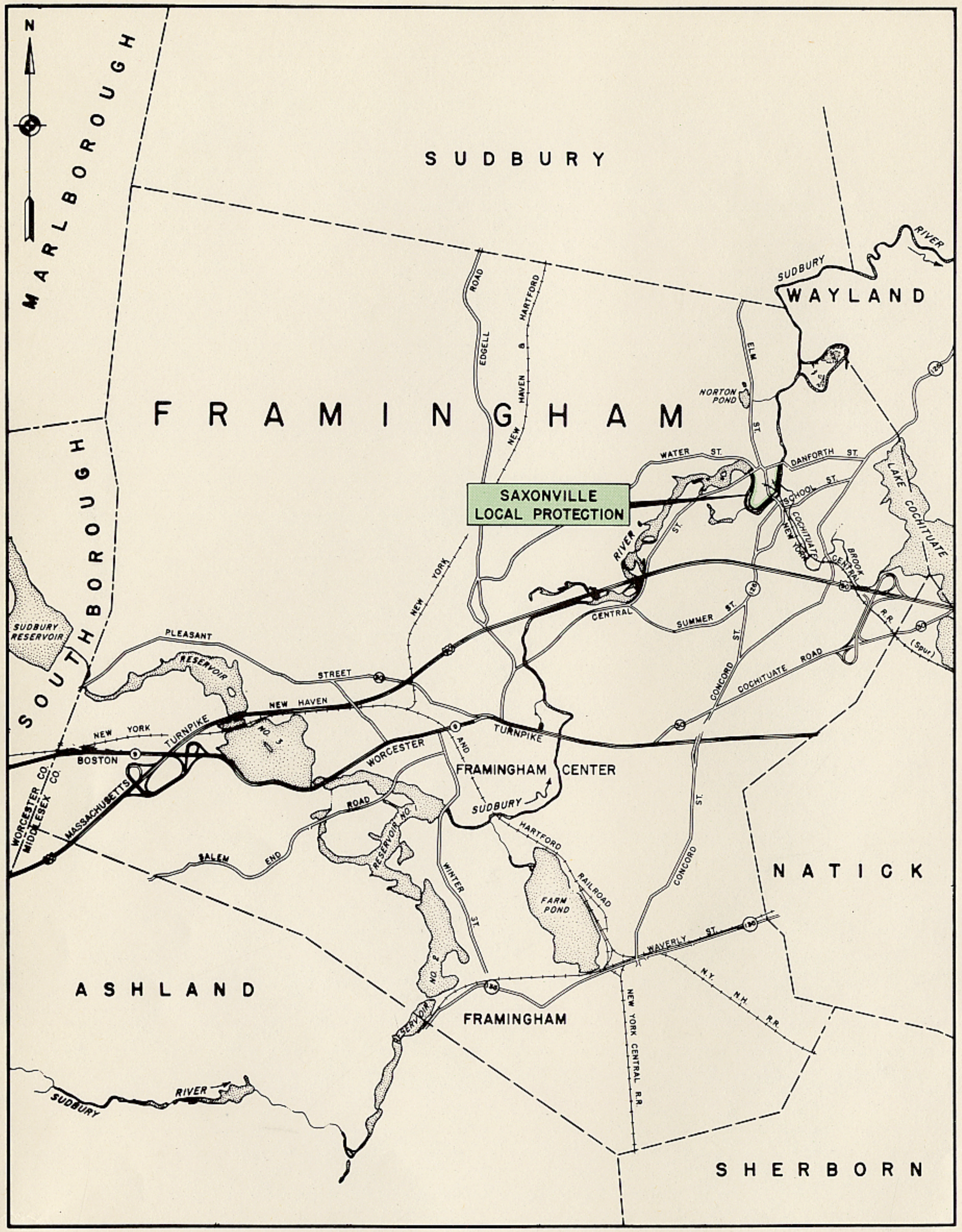
2. This report was prepared by C. N. Ciriello, Project Engineer, under the direction of Joseph L. Ignazio, Chief, Small Projects Section.

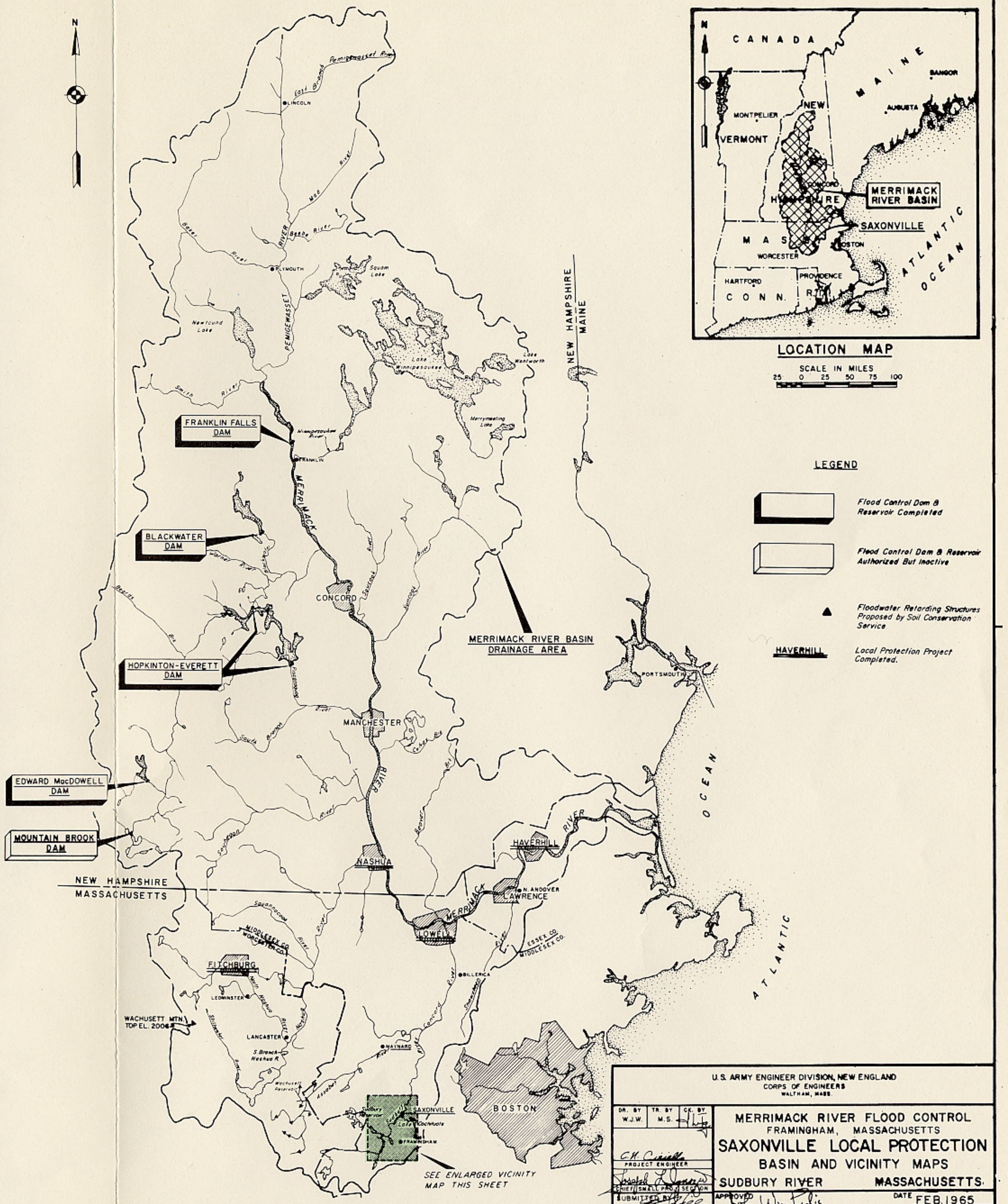
3. The U. S. Army Engineer Division, New England, is appreciative of the cooperation rendered in connection with this study by personnel of other Federal Agencies, State Agencies and Local Interests, particularly the following:

U. S. Department of Agriculture, Soil Conservation Service
Massachusetts Water Resources Commission
Town Officials, Framingham
Industrial Officials, Saxonville Area



VICINITY MAP

SCALE IN FEET



BASIN MAP

SCALE IN MILES

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
W.J.W.	M.S.	

PROJECT ENGINEER

CHIEF, SMALL PROJ. SECTION

SUBMITTED BY

CHIEF, PLANN. & RPTS BRANCH

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION
BASIN AND VICINITY MAPS
SUDBURY RIVER MASSACHUSETTS

APPROVED
CHIEF ENGINEERING DIV.

DATE FEB. 1965

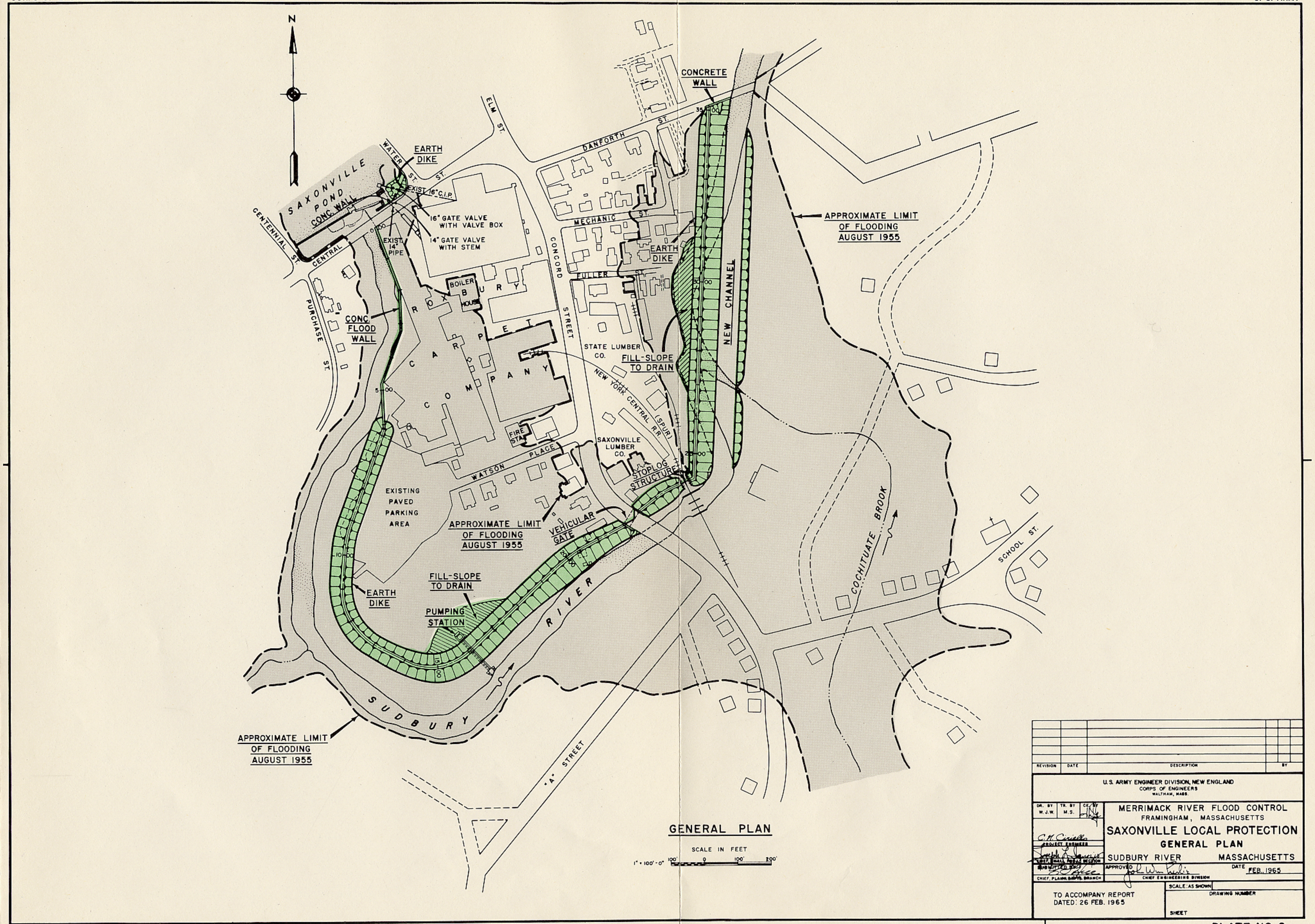
SCALE AS SHOWN

DRAWING NUMBER.

SHEET

TO ACCOMPANY REPORT
DATED: 26 FEB. 1965

PLATE NO. I


N
SAXONVILLE POND
CONC. WALL
EARTH DIKE
WATER ST.
EXIST. 16" C.I.P.
16" GATE VALVE WITH VALVE BOX
14" GATE VALVE WITH STEM
EXIST. 14" PIPE
CENTENNIAL ST.
CENTRAL ST.
PURCHASE ST.
CONC. FLOOD WALL
ELM ST.
DANFORTH ST.
MECHANIC ST.
FULLER ST.
CONCORD STREET
ROXBURY CARPET COMPANY
BOILER HOUSE
FIRE STA.
WATSON PLACE
EXISTING PAVED PARKING AREA
STATE LUMBER CO.
SAXONVILLE LUMBER CO.
NEW YORK CENTRAL R.R. (SPUR)
FILL-SLOPE TO DRAIN
STOPLOG STRUCTURE
VEHICULAR GATE
CONCRETE WALL
NEW CHANNEL
APPROXIMATE LIMIT OF FLOODING AUGUST 1955
EARTH DIKE
FILL-SLOPE TO DRAIN
PUMPING STATION
SUDBURY RIVER
"A" STREET
COCHITUATE BROOK
SCHOOL ST.
APPROXIMATE LIMIT OF FLOODING AUGUST 1955
APPROXIMATE LIMIT OF FLOODING AUGUST 1955
GENERAL PLAN
SCALE IN FEET
1" = 100'-0" 100' 0 100' 200'
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
DR. BY W.J.W.
TR. BY M.S.
MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION
GENERAL PLAN
SUDBURY RIVER MASSACHUSETTS
PROJECT ENGINEER
SUBMITTED
CHIEF, PLANNING BRANCH
APPROVED
CHIEF ENGINEERING DIVISION
DATE FEB. 1965
SCALE: AS SHOWN
DRAWING NUMBER
SHEET
TO ACCOMPANY REPORT
DATED: 26 FEB. 1965

APPENDICES

A	Hydrology and Hydraulics
B	Flood Losses and Benefits
C	Project Descriptions and Costs
D	Letters of Comment and Concurrence

APPENDIX A

HYDROLOGY AND HYDRAULICS

APPENDIX A

HYDROLOGY AND HYDRAULICS

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APPENDIX A

HYDROLOGY AND HYDRAULICS

1. INTRODUCTION

This appendix presents climatological and hydrological data applicable to the development of a flood protection plan for the Saxonville area in Framingham, Massachusetts, and includes analyses of floods of record, development of synthetic floods, and analyses of various flood control measures.

2. DESCRIPTION OF SUDBURY RIVER

The Sudbury River, draining a watershed of 163 square miles, originates in Cedar Swamps in the town of Westborough, Massachusetts and meanders about 30 miles to its confluence with the Assabet River. The topography of the basin is hilly with maximum elevations ranging from 500 to 600 feet. The slope of the river varies from about 11 feet per mile in the upper reaches to about one foot per mile in the lower reaches. The Metropolitan District and Water Resources Commissions maintain eight reservoirs in the Sudbury basin, four of which are used for water supply and four for recreation. These reservoirs, shown on Plate No. A-1, have a large modifying effect on all floods. Downstream of Reservoir No. 1 the Sudbury River meanders in a general northeasterly direction to Saxonville Dam where there is a drop of about 30 feet. From Saxonville Dam, the Sudbury River travels through the project area making a "U" and then flows in a northerly direction until it joins the Concord River. This reach of the river is very flat and contains a large amount of valley storage which greatly modifies flood flows.

3. HYDROLOGIC STUDIES BY OTHER AGENCIES

The Department of Agriculture, Soil Conservation Service, has made hydrologic studies of the Sudbury River. One such study was made to determine if any flood control benefit could be derived by reregulation of the eight State operated reservoirs. At present, all the reservoirs are drawn down from 1 to 3 feet during the summer months and 2 to 7 feet during the winter months. Results of the SCS study indicated that reregulation of the reservoirs would not provide any significant reduction in flood stages at Saxonville during major floods. In another study, a work plan was devised for Baiting Brook which enters the Sudbury River upstream of Saxonville. This work plan would not have any appreciable effect on flood flows at Saxonville.

Following the August 1955 flood, the Commonwealth of Massachusetts made some channel modifications and also repaired some bridges in the Sudbury watershed. One of the modifications included removal of a bridge and realignment of the Sudbury River about one mile downstream from the project area. Flood stages will be reduced about two feet at the improvements, but will be negligible at Concord Street bridge in Saxonville for a recurring August 1955 flood.

4. CLIMATOLOGY

The Sudbury River watershed, which drains into the Concord River and thence into the lower Merrimack River, is located within the influence of constant conflicts between cool dry air masses moving in from polar regions and moisture-bearing tropical, marine air from the south and east. This results in a succession of alternate low pressure or cyclonic disturbances, accompanied by snow or rain and high pressure or anti-cyclonic disturbances characterized by cool, dry conditions. Precipitation and temperature data are tabulated in Table A-1.

a. Temperature. - The average annual temperature in the lower Merrimack River basin is about 48° F. Recorded temperature extremes at representative stations within the watershed have varied from occasional highs slightly in excess of 100° F. to infrequent lows below minus 25° F.

b. Precipitation. - The mean annual precipitation over the southern portion of the Merrimack River basin is about 44 inches uniformly distributed throughout the year. The range between maximum and minimum values of average monthly rainfall at any one station is no greater than one inch. At Framingham, Massachusetts the maximum monthly precipitation recorded was 15.69 inches occurring in August 1955, while at Lowell, Massachusetts the maximum was 12.81 inches measured in July 1938.

c. Snowfall. - Most of the precipitation during the winter months is in the form of snow. The average annual snowfall varies from about 60 inches at Fitchburg, Massachusetts to about 49 inches at Framingham, Massachusetts. In the tributary headwater areas where the snowfall is greatest, the snow cover often remains until the middle of March or early April. The melting of this snow cover during spring thaws, especially if accompanied by heavy rainfall, is one of the principal causes of floods in the Sudbury River basin.

d. Storms. - Outstanding floods may result from early spring storms combined with melting snow such as the flood of March 1936 or from summer or fall storms such as the record floods of August 1955 and September 1954. In addition, local thunderstorms can cause serious flash floods on the smaller streams.

TABLE A-1

CLIMATOLOGICAL DATA
LOWELL, MASS. - Elevation 90 Ft.

PRECIPITATION(Inches)

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Average	135	3.35	3.14	3.66	3.55	3.36	3.29	3.56	3.99	3.38	3.39	3.82	3.41	41.87
% of Ave. Annual	-	8	8	9	8	8	8	9	9	8	8	9	8	100
Maximum	135	9.20	9.91	8.94	10.23	8.50	10.40	12.81	12.31	10.96	8.33	8.82	8.63	59.49
Yr. of Max.	-	1958	1900	1953	1901	1954	1922	1938	1856	1868	1955	1921	1901	1888
Minimum	135	0.34	0	0	0.29	0.30	0.38	0.83	0.18	0.12	0.04	0.60	0.33	27.85
Yr. of Min.	-	1837	1838	1915	1844	1878	1873	1929	1854	1914	1924	1902	1828	1914
Ave. Snowfall(Unmelted)	27	16.2	13.0	10.3	1.9	T	0	0	0	0	T	2.3	8.8	52.0

TEMPERATURE(Degrees F.)

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Average	76	25.5	26.2	35.3	46.6	58.3	67.0	72.7	70.3	63.3	52.3	40.7	29.3	49.0
Ave. Maximum	76	34.4	35.3	44.1	57.4	69.7	78.0	83.4	80.8	74.0	62.7	49.1	37.3	58.8
Ave. Minimum	76	16.5	17.1	26.5	35.8	46.8	56.2	62.1	59.9	52.5	41.9	32.3	21.2	39.1
Absolute Maximum	74	68	69	80	90	98	100	103	103	100	89	81	64	103
Yr. of Abs. Maximum	-	1950	1957	1945	1941	(1)	1952	1911	1948	1953	1947	1950	1950	1911
Absolute Minimum	74	-26	-29	-14	6	28	37	44	40	28	20	3	-20	-29
Yr. of Abs. Minimum	-	(1)	1943	1923	1923	(1)	(1)	(1)	1908	(1)	(1)	1938	1933	1943

FRAMINGHAM, MASS. - Elevation 170 Ft.

PRECIPITATION(Inches)

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Average	85	3.99	3.76	4.24	3.69	3.24	3.29	3.53	3.74	3.52	3.35	3.95	3.85	44.19
% of Ave. Annual	-	9	9	10	8	7	7	8	8	8	8	9	9	100
Maximum	85	9.67	8.82	9.61	8.78	7.01	9.33	11.80	15.69	10.65	10.26	7.94	10.87	59.94
Yr. of Max.	-	1958	1900	1936	1904	1901	1922	1938	1955	1933	1890	1895	1901	1888
Minimum	85	0.75	0.26	0.04	0.85	0.72	0.38	0.73	0.54	0.18	0.10	0.89	0.92	31.95
Yr. of Min.	-	1955	1877	1915	1892	1911	1912	1952	1883	1914	1924	1908	1877	1883
Ave. Snowfall(Unmelted)	27	13.8	12.5	10.0	1.6	T	0	0	0	0	T	2.2	8.7	49.3

TEMPERATURE(Degrees F.)

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Average	76	26.7	26.9	36.2	47.3	58.4	67.1	72.2	69.8	62.9	52.2	41.5	30.0	49.3
Ave. Maximum	30	36.8	38.1	46.5	59.0	71.7	80.3	85.2	83.1	75.5	64.8	52.4	39.5	61.1
Ave. Minimum	30	18.2	18.6	27.1	37.0	46.7	55.8	61.2	59.4	51.8	41.6	32.8	21.6	39.3
Absolute Maximum	76	72	70	85	90	96	100	104	104	101	89	83	67	104
Yr. of Abs. Max.	-	1950	1957	1945	1938	1911	1952	1911	1948	1953	1947	1950	(1)	1911
Absolute Minimum	76	-24	-21	-3	10	25	35	42	34	27	16	7	-16	-24
Yr. of Abs. Min.	-	1904	1943	1923	1923	(1)	1907	(1)	1908	(1)	(1)	1938	1933	1904

(1) Occurred prior to 1931

TABLE A-1 (Continued)

FITCHBURG, MASS. - Elevation 400 Ft.

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
PRECIPITATION (Inches)														
Average	96	3.49	3.23	3.66	3.44	3.59	3.65	3.74	3.77	3.62	3.49	3.71	3.32	42.71
% of Ave Annual	-	8	8	9	8	8	8	9	9	8	8	9	8	100
Maximum	96	7.78	8.33	12.15	9.91	8.25	11.56	12.68	10.72	14.04	13.01	7.63	8.46	60.23
Yr. of Max.	-	1936	1866	1936	1901	1893	1944	1897	1867	1868	1869	1927	1901	1888
Minimum	96	0.84	0.34	T	0.57	0.57	0.09	0.46	0.17	0.19	T	0.38	0.58	27.45
Yr. of Min.	-	1955	1877	1915	1892	1878	1873	1957	1876	1914	1924	1882	1875	1883
Ave. Snowfall(Unmelted)	75	15.2	16.9	10.9	2.3	T	0	0	0	0	T	3.4	10.9	60.6
TEMPERATURE (Degrees F.)														
Average	74	25.1	25.2	34.5	46.1	57.8	66.3	71.4	69.1	62.1	51.2	39.8	28.6	48.1
Ave. Maximum	74	33.4	34.4	43.9	56.5	69.4	77.4	82.2	79.9	72.8	61.9	48.6	36.4	58.1
Ave. Minimum	75	16.7	16.0	25.0	35.7	46.2	55.3	60.7	58.3	51.4	40.4	31.0	20.8	38.1
Abs. Maximum	76	68	68	86	92	97	100	103	102	101	91	81	66	103
Yr. of Abs. Max.	-	1937	1957	1945	1941	1944	(1)	1911	1944	1953	1938	1950	1941	1911
Absolute Minimum	77	-21	-21	-8	6	27	35	41	38	27	16	-2	-16	-21
Yr. of Abs. Min.	-	1957	1943	1943	1923	1956	1958	1945	(1)	1914	1936	1938	(1)	1957

CLINTON, MASS. - Elevation 398 Ft.

ITEM & DESCRIPTION	YEARS OF RECORD	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
PRECIPITATION (Inches)														
Average	59	4.00	3.64	4.22	3.88	3.45	3.90	3.78	3.93	3.73	3.29	4.05	3.89	45.74
% of Ave. Annual	-	9	8	9	8	8	9	8	9	8	7	9	8	100
Maximum	59	9.07	7.22	10.24	8.63	7.32	12.19	10.15	15.39	11.14	9.15	9.15	6.92	59.27
Yr. of Max.	-	1958	1909	1936	1904	1912	1903	1938	1955	1934	1955	1927	1927	1927
Minimum	59	0.65	1.33	0.06	0.92	0.61	0.27	0.39	0.99	0.25	0.04	0.93	0.71	31.96
Yr. of Min.	-	1955	1957	1915	1941	1959	1912	1957	1929	1914	1924	1902	1943	1957
Ave. Snowfall(Unmelted)	60	15.6	15.8	10.7	2.6	T	0	0	T	0	T	3.0	9.6	57.4
TEMPERATURE (Degrees F.)														
Average	54	25.7	25.5	34.5	45.0	56.8	65.3	70.6	68.5	61.6	51.8	41.0	29.7	48.0
Ave. Maximum	28	35.2	36.4	43.8	56.0	67.8	75.1	80.0	78.5	71.5	62.2	50.6	38.3	58.0
Ave. Minimum	28	17.2	16.9	25.3	35.6	46.7	56.2	59.3	59.9	52.4	42.2	32.9	21.4	38.8
Absolute Maximum	52	64	67	82	89	92	98	100	98	96	86	78	66	100
Yr. of Abs. Max.	-	1950	1951	1945	(1)	(1)	(1)	1911	1949	1953	1947	1950	(1)	1911
Absolute Minimum	52	-21	-22	- 8	3	16	31	45	34	28	21	-1	-19	-22
Yr. of Abs. Min.	-	1938	1943	1943	(1)	(1)	(1)	1946	1908	1914	1936	1938	1933	1943

(1) Occurred prior to 1931

5. RUNOFF AND STREAMFLOW DATA

a. Discharge Records. - The geographical locations and summary of pertinent data at each of five U. S. Geological Survey gaging stations in the lower part of the Merrimack River basin are shown on Plate No. A-1 and tabulated in Table A-2.

b. Runoff. - Discharge is measured at U. S. Geological Survey gaging stations on the Merrimack River and its principal tributaries. Flow data applicable to the southern portion of the basin were obtained from gaging stations on the Assabet and Concord Rivers. The maximum, minimum and mean monthly runoff at the gaging stations for the period of record through 1962 is given in Table No. A-3.

6. FLOODS OF RECORD

a. Notable Floods. - Four major floods have occurred in the Sudbury River watershed in recent years. Records indicate that serious floods can be expected to occur during any season of the year. The flood of August 1955 was the greatest flood of record on the Sudbury River. Other major floods occurred in March 1936, July 1938 and September 1954.

b. Historic Floods. - Records of river stages at Framingham Center have been maintained by the Metropolitan District Commission since 1875. Notable floods occurring prior to the turn of the century were recorded in February 1886 and March of 1888.

7. FLOOD FREQUENCIES

Peak discharge frequency curves were computed in 1952 for all gaging stations and damage zones in the Merrimack River basin. Following the August 1955 floods, basic data from the previous study were brought up-to-date and the frequency curves recomputed. The frequency analyses were made in accordance with the procedures devised by Mr. L. R. Beard and described in Civil Works Engineering Bulletins 51-1 and 51-14. The initial applications to New England rivers are summarized in FCS Memorandum No. 52-General-3, "Flood Frequency Studies in New England". In the frequency studies initiated following the 1955 floods, the mean and standard deviations were recomputed to include five years of additional flow data. Based on a regional analysis, a skew coefficient of 0.8 was adopted for the Merrimack River basin instead of a skew coefficient of 0.3 previously used.

Although there are no reliable peak discharge records on the Sudbury River at Saxonville, flood peaks were estimated for all the recent major floods. The flood discharges were arranged in descending order and a frequency curve was developed graphically. For

TABLE A-2

MERRIMACK RIVER BASIN
STREAMFLOW RECORDS
THROUGH WATER YEAR 1962

Location of Gaging Station	Drainage Area (sq.mi.)	Period of Record	Mean (cfs)	Instantaneous Maximum (cfs)	Daily Minimum (cfs)
South Branch Nashua River at Clinton, Mass.	107.7	1896-	191	-	-
Assabet River at Maynard, Mass.	116	1941-	183	4,250 (3)	0.8
Sudbury River at Framingham Center, Mass.	75.2	1875-	113	-	-
Concord River below River Meadow Brook at Lowell, Mass.	405	1936-	467 (1)	4,540 (4)	4.0
Merrimack River below Concord River at Lowell, Mass.	4635	1923-	7213 (2)	173,000 (5)	199

(1) Adjusted to net drainage of 312 square miles
(2) Adjusted for wastage, into Merrimack River
(3) Occurred August 1955
(4) Occurred August 1955
(5) Occurred March 1936

TABLE A-3

MONTHLY RUNOFF (CFS)

Month	Concord River Below River Meadow Brook at Lowell, Mass. (DA - 405 square miles) Oct 1936 - Sept 1962			Assabet River at Maynard, Mass. (DA - 116 square miles) July 1941 - Sept 1962		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	597	1136	181	209	439	52
February	697	1381	318	234	458	96
March	1101	1668	660	409	647	232
April	1124	2189	630	381	741	202
May	703	1196	283	240	443	119
June	427	962	160	134	336	39
July	244	1512	50	64	254	22
August	211	1208	36.6	69	561	10
September	249	1151	22.8	73	542	5
October	239	950	38.3	72	375	10
November	400	1346	91.1	145	542	22
December	571	1152	146	166	458	36
ANNUAL	547	889	292	183	286	93

economic analysis an excedence frequency of one percent was assigned to the August 1955 flood discharge. The elevation associated with this flood was the highest observed in recent years and also the highest estimated from historical floods. The elevation-frequency curve is shown on Plate No. A-3.

8. STANDARD PROJECT FLOOD

a. Standard Project Storm. - Analyses of past floods on the Sudbury River revealed that due to the large modifying effect of the water supply reservoirs and the natural valley storage, volume of rainfall rather than rainfall intensity produce floods in this basin. The sluggish characteristics of the basin are evident from the low peak discharges resulting from major storms. At Concord Street bridge which is located within the protection area and just upstream of Cochituate Brook, estimates of peak discharges from past floods of record have been determined and are shown in the following table. Also shown in this table are the average rainfall amounts over the basin that produced the floods compared with the rainfall of a standard project storm.

Flood	Sudbury River at Concord Street Bridge (1) Peak Discharges		Sudbury River Basin Average Rainfall (inches)
	(cfs)	(csm)	
Mar. 1936	2050	23.9	4 (2)
July 1938	1800	21.0	8.0
Sep. 1954	2850	33.2	8.5
Aug. 1955	3950	46.0	12.5
Standard Project Storm			13.3

(1) Drainage Area of 85.9 square miles.
(2) Flood produced by combination of rainfall and snowmelt.

It is noted that the SPS, based on 72-hours duration, is only about 6 percent greater than the experienced August 1955 storm.

b. Standard Project Flood Discharge. - From a comparison with past storms and runoff with standard project storm, the standard project flood discharges were estimated as follows:

Location	Drainage Area (sq.mi.)	Design Discharge (cfs)
Sudbury River downstream Cochituate Brook	106	5,800
Sudbury River upstream Cochituate Brook	86	5,000

The SPF discharges are about 25 percent greater than the maximum flood of record to reflect the uncertainties associated with the available flood control storage at the State-owned reservoirs at the time of the SPS. The reservoirs upstream of Reservoir No. 1 are presently drawn down each summer to provide some flood control storage during the hurricane season. At Reservoir No. 1 (DA - 75.2 square miles), the outlet of the reservoir system, the drawdown amounts to about one inch of storage. There is, however, over three inches of surcharge storage in the system making a total of about four inches of storage available to modify flood flows.

9. DESCRIPTION OF IMPROVEMENTS

a. General. - The proposed plan of improvement would be located along the left bank of the Sudbury River, extending from the Saxonville Pond dam at Central Street to the Danforth Street bridge, a distance of about 3,800 feet. A section of the river between N. Y. Central Railroad bridge and Danforth Street bridge would be straightened to provide a new channel about 1,200 feet in length with a 60-foot bottom width. The project would include construction of about 2,900 feet of earth dikes, 750 feet of concrete floodwalls, one flood gate to be located at Concord Street, one stoplog structure at the New York Central railroad spur crossing, and one pumping station with appurtenant structures to be located about 600 feet upstream from the Concord Street bridge.

b. Water Surface Profiles. - Water surface profiles on the Sudbury River for several flows were computed by the Soil Conservation Service, taking into account all improvements made to the channel following the August 1955 flood. A rating curve at Danforth Street was plotted from the profile data to arrive at the starting water surface elevation for the design flood. From Danforth Street upstream to the New York Central railroad bridge, flood flows spread out on an extensive flood plain on the right bank. Confining the flow by a dike on the left bank would not have any appreciable effect on flood elevations in this reach of river. A rating curve downstream of the New York Central railroad bridge indicated an elevation only 0.4 foot higher than the starting elevation at Danforth Street bridge.

From Concord Street bridge upstream to Saxonville Dam, the Sudbury River will be more or less confined between the banks of the river with improvements. The design water surface elevation was computed from backwater using an "n" value of 0.030. Average velocities range from about three feet per second at Concord Street to about six fps at the upper end of the project. Losses through Concord Street and the railroad bridges were estimated at slightly over one foot each which allows for some accumulation of debris. The design water surface elevation at the headwater of the Saxonville Dam was computed to be 149.7 feet, m.s.l.

Freeboard allowances of about three feet were used throughout the project except between Concord Street and the railroad bridge. The protective works in this short reach have a freeboard of about 3.5 feet because of uncertainties of debris clogging up the bridge openings. A profile of the design discharges is shown on Plate No. A-2.

10. INTERIOR DRAINAGE

a. General. - The interior drainage analysis was developed in accordance with design procedures outlined in EM 1110-2-1410, "Interior Drainage of Leveed Urban Areas: Hydrology".

b. Description of Area. - The interior drainage area within the system of dikes and floodwalls comprises approximately 35 acres of which about 75 percent is industrial, residential, or commercial. Paved parking areas and small grassed lots comprise the remaining 25 percent. The slope of the topography is relatively flat. The Class I (concentrated commercial and industrial sections) has been selected as being indicative of the area.

The storm drainage system, which is essentially separate from the sanitary sewer system, includes several outfalls to the river. The 35-acre drainage area includes about seven acres which are normally intercepted by storm drainage and discharged outside of the area. During intense rainfall, it is assumed that most of the runoff would bypass the catch basins and flow into the protected area.

c. Unit Hydrographs. - Synthetic one-hour unit hydrographs were developed for the 2, 10 and 100 year rainfall frequencies. The peak values of the unit graphs were derived from estimated "C" values as used in the conventional rational formula. The adopted one-hour unit hydrographs are shown on Plate No. A-3. Peak values of the one-hour unit hydrographs for the 35 acres are tabulated below.

Frequency (years)	Peak (cfs)	t_p (hrs)
2	26	1.00
10	27	0.96
100	34	0.77

d. Design Storm. - Precipitation data for the 2, 10, and 100 year frequency storms have been taken from the U. S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States" dated May 1961. Infiltration and other losses were assumed at a rate of 0.10 inch per hour. A tabulation of the six-hour rainfall amounts for the 2, 10 and 100 year frequency storms are shown on Plate No. A-3.

e. Runoff Hydrographs. - Runoff hydrographs resulting from the 2, 10 and 100 year frequency storms were computed by applying six-hour rainfall excesses derived for each rainfall frequency to the synthetic unit hydrographs. The inflow hydrographs to the protected area, not including seepage and process water, have peaks of 30, 49, and 88 c.f.s., respectively. The runoff hydrographs are shown on Plate No. A-3.

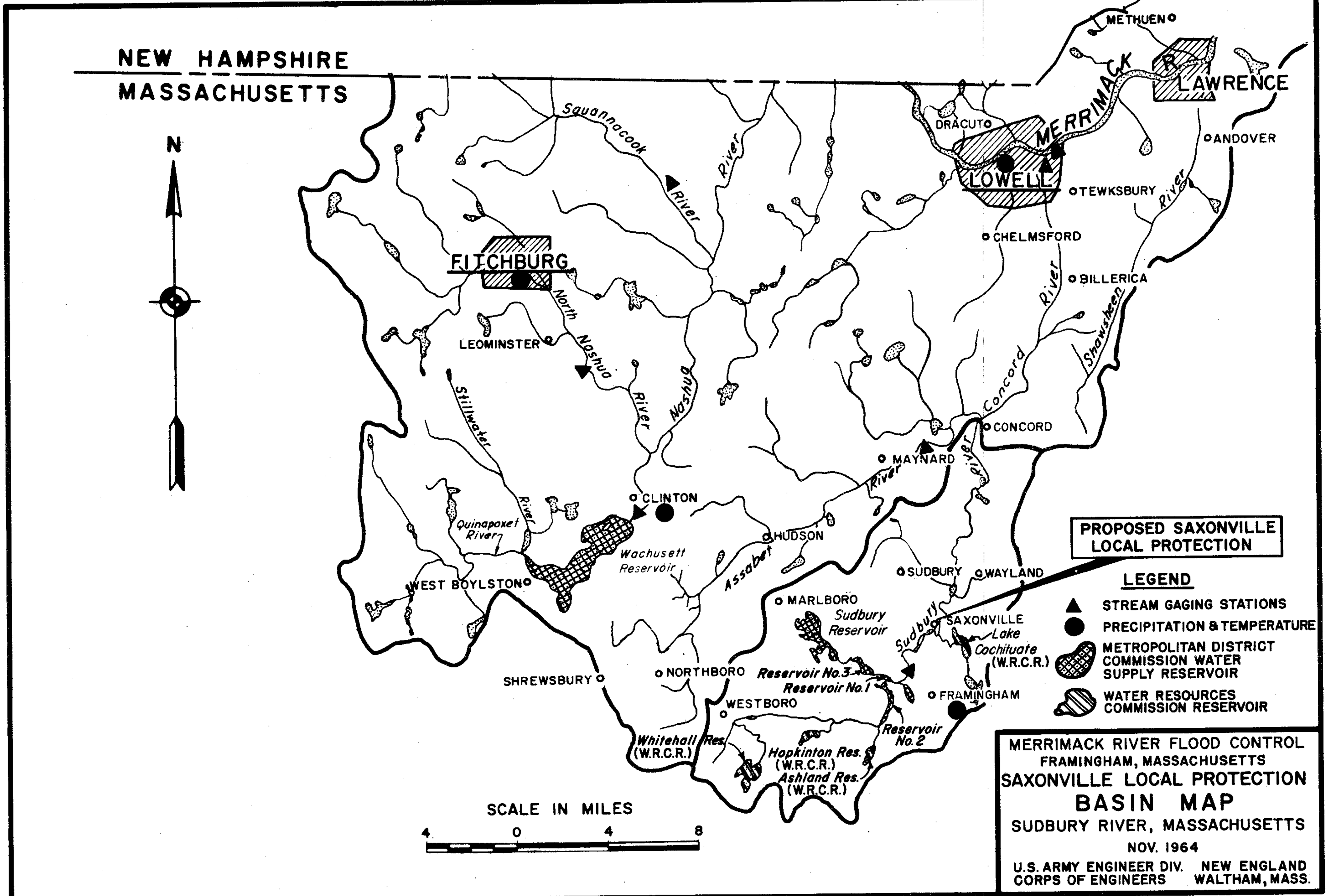
f. Seepage and Other Flows. - Consideration has been given to the amount of seepage and other flows anticipated within the protected area. During maximum river stage, the rate of seepage was estimated to be 8.5 c.f.s. Process water from the Roxbury Carpet Company was estimated to be about 1.5 c.f.s.

g. Ponding. - There are no existing ponding areas capable of storing the interior runoff during the design storm, nor are there any existing provisions for diversion. The only undeveloped land of any appreciable size is located adjacent to the pumping station. This area, amounting to approximately 5.5 acres, includes a 2.5 acre paved parking lot. The lowest ground elevation behind the proposed dike and wall will be 118 feet m.s.l. The elevation at which damage begins, under present conditions, is 121 feet m.s.l. The storage capacity of the ponding area at this stage will be 1.3 acre-feet, equivalent to about 0.44 inch of runoff from the 35 acres. The area-capacity curve is shown on Plate No. A-3.

h. Pumping Station. - One pumping station to handle interior runoff is required at the project. The location of the pumping station is shown on Plate No. A-2. The runoff hydrographs of the 2, 10 and 100 year storms, including seepage and process water, were routed through the ponding area, assuming various pumping capacities. A graphical presentation of ponding elevations resulting from the 2, 10 and 100 year rainfall frequency storms with various pumping capacities is shown on Plate A-3. The design of the pumping station was predicated on storm conditions coincident with high river levels. The standard project storm followed by the occurrence of a 10-year storm was used in the selection of the pumping station capacity. This criteria along with Stage B represents the most practical balance between pumping, storage, and the potential damage from more severe storms. A pumping station capacity of 35 c.f.s. was selected resulting in shallow inundation to elevations of 118.8 m.s.l. for Stage A, 121.0 m.s.l. for Stage B and 123.0 m.s.l. for Stage C.

Consideration was given to the development of a relationship between coincident rainfall and river stages; however, due to the lack of information and the scope of the project, its application was neglected.

The gravity outfall from within the protected area to the Sudbury River is a 48-inch conduit. A conduit of this size is more than adequite to discharge a runoff of 88 c.f.s. derived from a 100-year frequency storm.



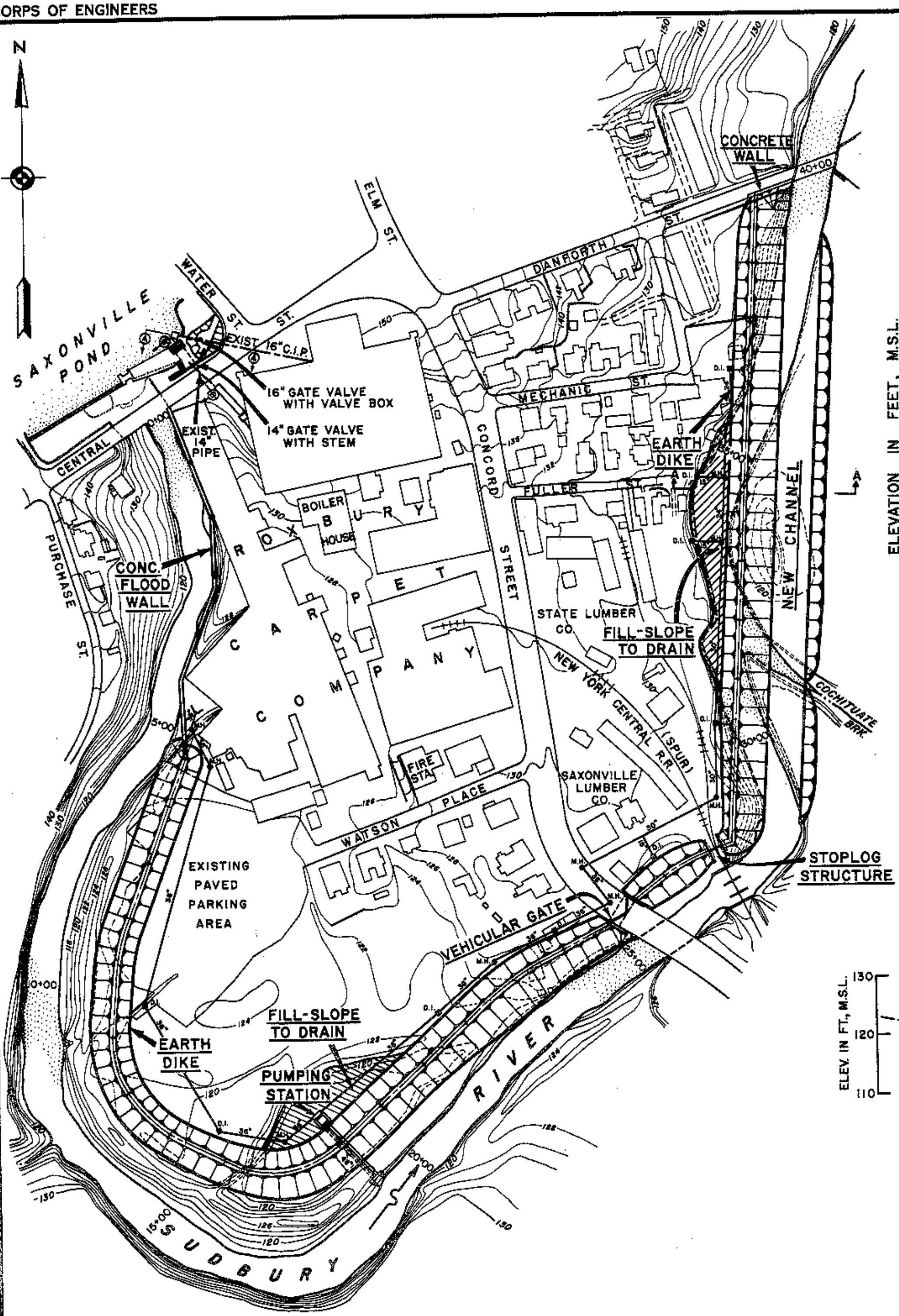
MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION

BASIN MAP

SUDBURY RIVER, MASSACHUSETTS

NOV. 1964

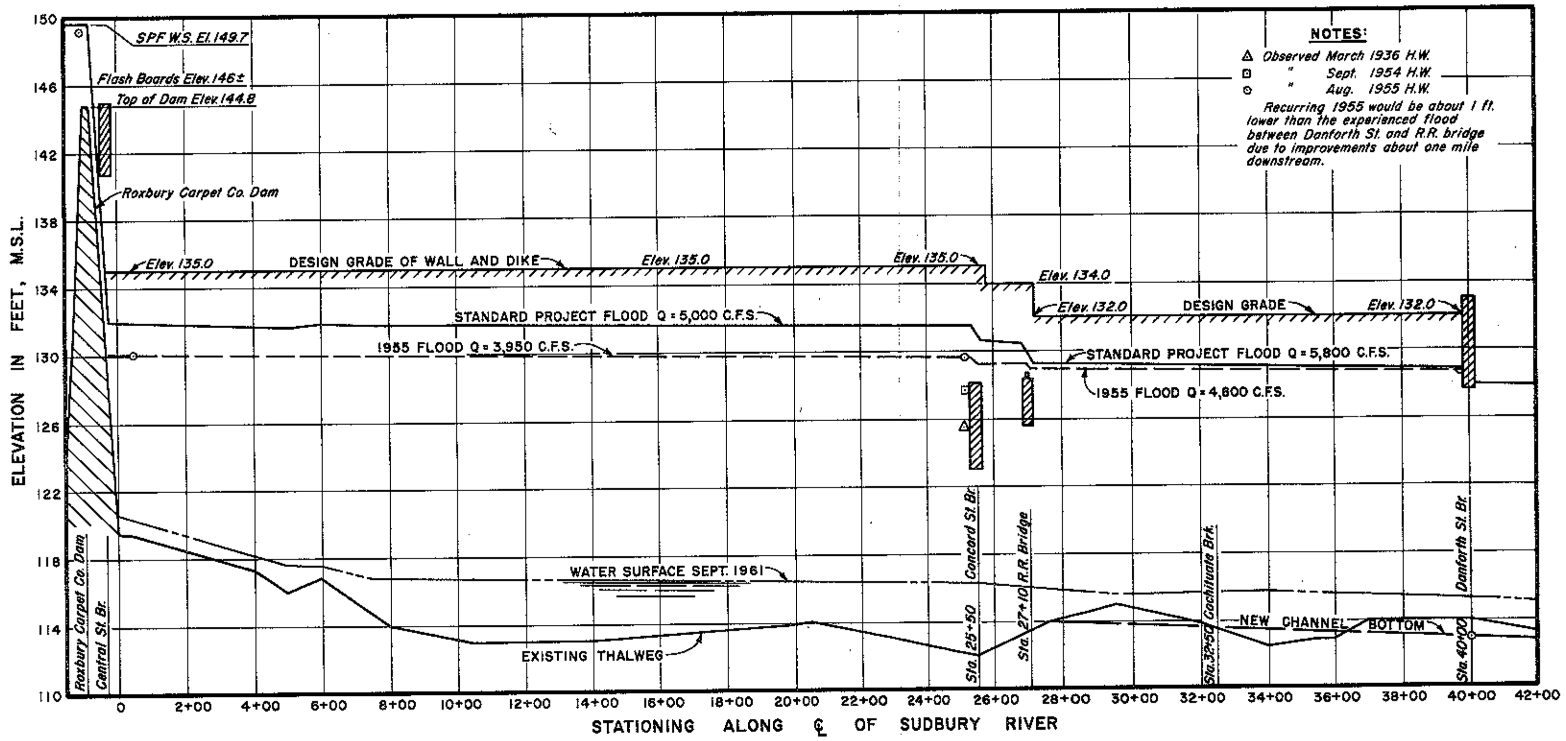
U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.



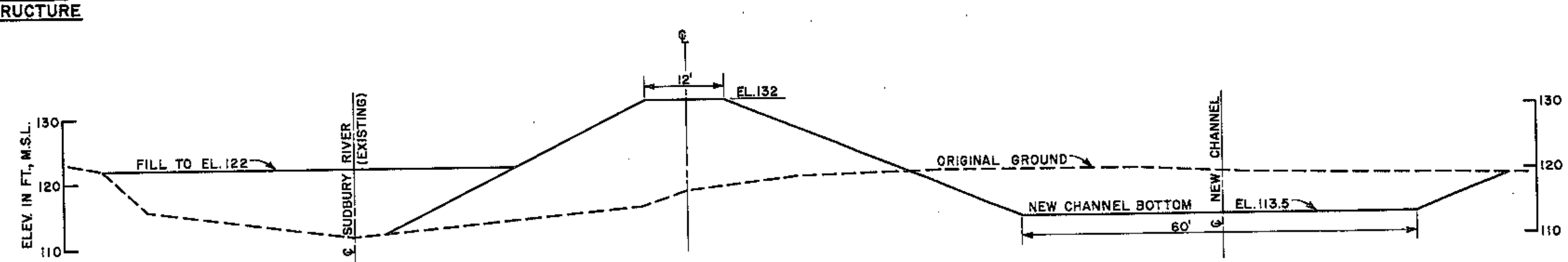
GENERAL PLAN

SCALE IN FEET

1" = 100'-0" 100' 0 100' 200'



PROFILE OF SUDBURY RIVER AT SAXONVILLE, MASSACHUSETTS



SECTION A-A

SCALE:
HOR. 1" = 10'
VERT. 1" = 10'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
O.L.D.	M.S.	O.L.D.

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION
PLAN, PROFILE AND SECTION
SUDBURY RIVER MASSACHUSETTS

S. Cooper
ENGINEER

E. F. Childs
CHIEF, HYD.& HYD. SECTION

SUBMITTED BY
CHIEF, PLANN.& RPT'S BRANCH

APPROVED John Wm. Leslie
CHIEF ENGINEERING DIV.

DATE FEB. 1965

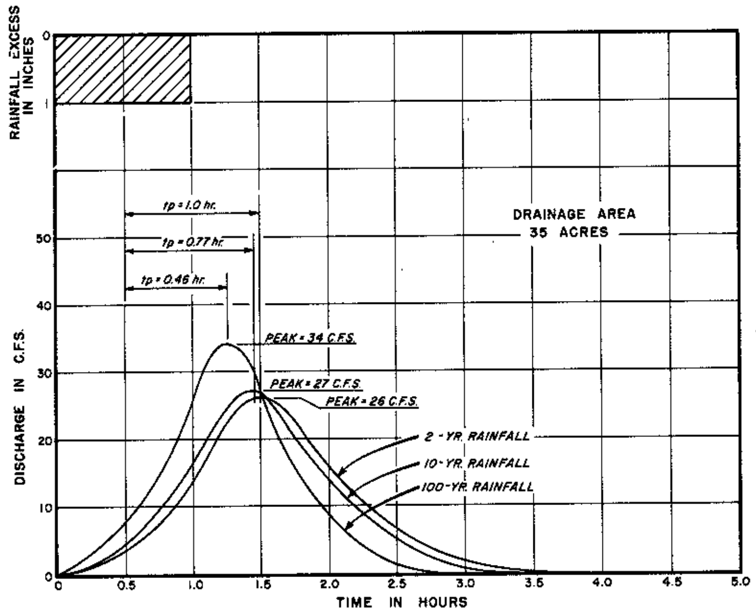
TO ACCOMPANY REPORT
DATED 26 FEB. 1965

SCALE: AS SHOWN

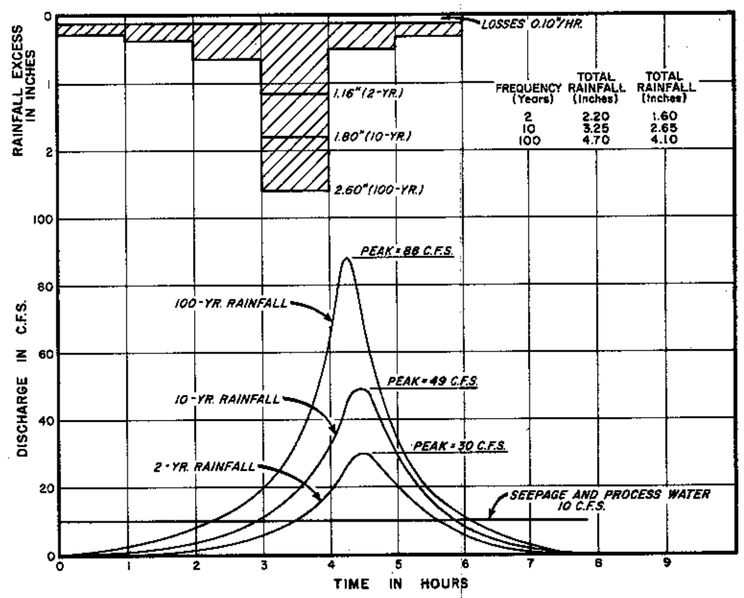
DRAWING NUMBER

SHEET

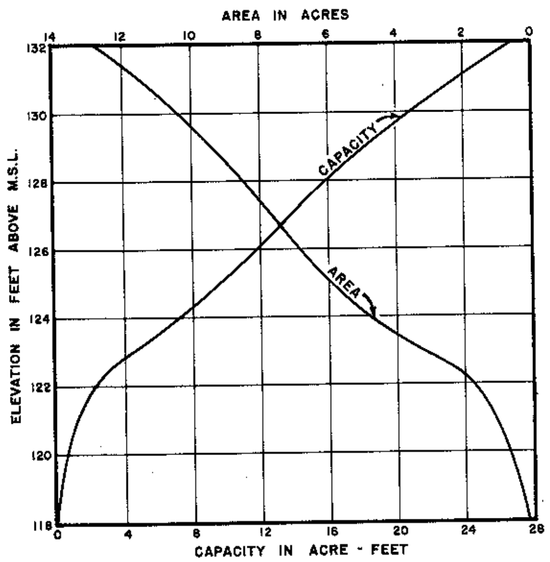
PLATE NO. A-2



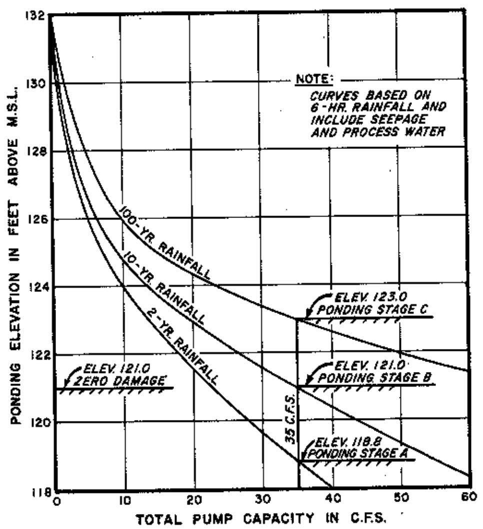
ADOPTED ONE HOUR UNIT HYDROGRAPHS



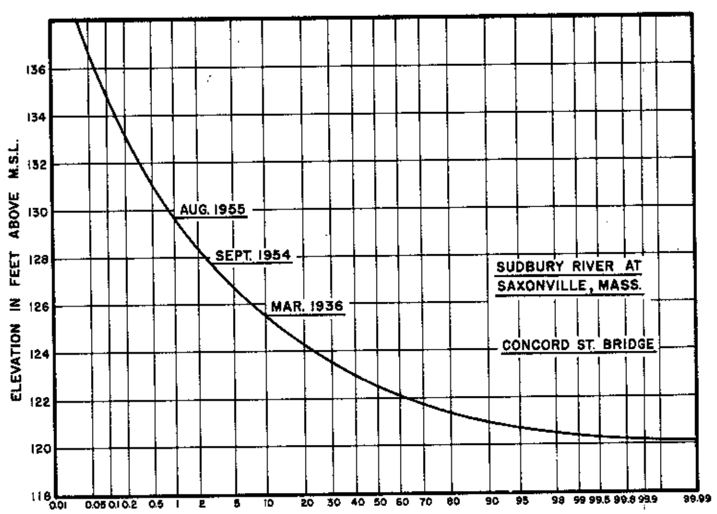
RUNOFF HYDROGRAPHS



AREA - CAPACITY CURVES



PONDING ELEVATION VS. PUMP CAPACITY



ELEVATION - FREQUENCY CURVE

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY O.L.D. | TR. BY M.S. | CK. BY O.L.D.

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS

SAXONVILLE LOCAL PROTECTION

HYDROLOGIC DATA

SUDBURY RIVER MASSACHUSETTS

S. Campbell ENGINEER
E. F. Childs CHIEF, HYD & HYD. SECTION
SUBMITTED BY: CHIEF, PLANN. & RPT'S BRANCH
APPROVED: CHIEF ENGINEERING DIV.
DATE FEB. 1965

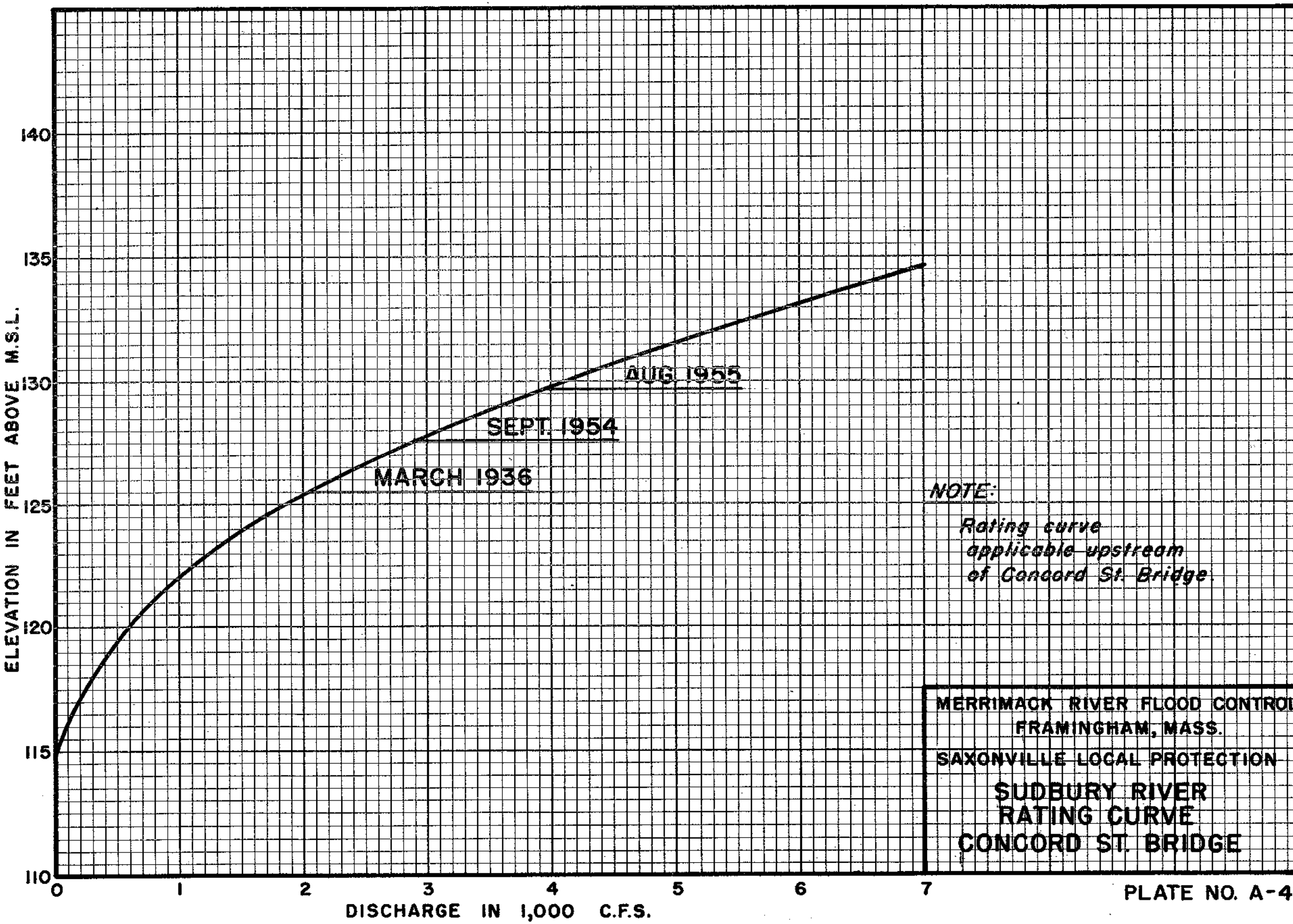
TO ACCOMPANY REPORT DATED 26 FEB. 1965

SCALE: AS SHOWN

DRAWING NUMBER

SHEET

PLATE NO. A-3



ELEVATION IN FEET ABOVE M.S.L.
140
135
130
125
120
115
110
0
1
2
3
4
5
6
7
DISCHARGE IN 1,000 C.F.S.
AUG. 1955
SEPT. 1954
MARCH 1936
NOTE:
Rating curve applicable upstream of Concord St. Bridge.
MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASS.
SAXONVILLE LOCAL PROTECTION
SUDBURY RIVER
RATING CURVE
CONCORD ST. BRIDGE

PLATE NO. A-4

APPENDIX B

FLOOD LOSSES AND BENEFITS

APPENDIX B

FLOOD LOSSES AND BENEFITS

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4.	AVERAGE ANNUAL LOSSES	B-2
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APPENDIX B

FLOOD LOSSES AND BENEFITS

1. DAMAGE SURVEYS

Following the flood of August 1955 when hurricane Diane dropped as much as 13 inches of rainfall in the area, the Soil Conservation Service, Department of Agriculture, made detailed damage surveys of the Concord, Sudbury and Assabet Rivers. Results of these surveys were made available to the Corps of Engineers, and were used as a basis for preliminary studies of those areas considered for flood protection. At Saxonville, a damage review was conducted by the Corps of Engineers in 1961 to determine the changes since 1955; to obtain detailed data for losses at intermediate stages; and to gather information for enhancement and growth studies. Early in 1964, an additional review was made of the area.

The damage survey review consisted of door-to-door interviews and inspections of residential, commercial, industrial and other properties within the flood plain. Recorded information included extent of the areas flooded, description of the properties, nature and amount of damages, depth of flooding, high water references and relationships to prior flood stages. Damage data were generally furnished by property owners or tenants. Engineers and analysts prepared estimates on the basis of these data and developed their own estimates when owner or tenant estimates were unavailable.

Sufficient data were obtained to derive losses for: (1) the 1955 flood crest, (2) a stage 3 feet higher, (3) the stage where damage begins referenced to the 1955 flood crest, and (4) intermediate stages where marked increases in damage occur.

2. LOSS CLASSIFICATION

Flood loss information was recorded by type of loss and by location. Primary losses evaluated include (1) physical losses, such as damage to structures, equipment and machinery, cost of cleanup and repairs, and (2) non-physical losses, such as unrecoverable loss of business and wages, cost of emergency services and increased cost of operation.

Primary losses resulting from physical damage and a large part of the related non-physical loss were determined by direct inspection of property and evaluation of losses by property owners and field investigators. Where non-physical portions of primary losses could not be directly determined with available data, estimates were based upon the relationship between physical and non-physical losses for similar properties in the area.

3. RECURRING LOSSES

A recurrence of the record flood stages of August 1955 under 1964 economic conditions in Saxonville would cause losses estimated at $1,040,000. All but $145,000 of this loss would occur on the left bank of the river with a substantial portion of the damage occurring to the sprawling industrial complex which makes up the Roxbury Carpet Company. This plant, the third largest employer in Framingham, would suffer losses in raw and finished stock plus a payroll loss estimated at $35,000 weekly. Two thriving building supply concerns, a fuel oil business, a welding shop, and an auto body shop are among the commercial facilities which would suffer losses on the left bank as well as 23 residential properties housing 41 families. Public losses would include damage to a fire station, the American Legion clubhouse and a sewage pumping station. On the right bank, 17 commercial properties and 5 dwellings would suffer some losses.

4. AVERAGE ANNUAL LOSSES

Estimated recurring losses for various stages of flooding were correlated with stage frequency data to derive curves of damage frequency, the measure of annual losses in the study area. Annual losses amount to $74,000 on the left bank and $7,000 on the right bank in Saxonville under current conditions.

5. TRENDS OF DEVELOPMENT

The population growth in towns on the Concord River and its tributaries during the decade 1950-1960, percentage wise, has been the highest in the state, amounting to 59 percent as compared with a growth of 16 percent for Middlesex County as a whole and 9.8 percent for the State. The Town of Framingham grew at the rate of 58 percent. Rated 40 percent urbanized in 1950, it was completely urbanized by 1960 according to the 1960 census.

Framingham has had an industrial and commercial development which matches its population growth. The Boston and Albany and the New Haven Railroads serve the town. The Massachusetts Turnpike (Interstate Route I-90), the Worcester Turnpike (Route 9) and Route 128 (the Circumferential Highway which circumscribes Boston at a radius of 9 miles) provide excellent motor transportation in all directions. New industries, including such firms as General Motors, Carling Brewing Company, and the Quartermaster Research Laboratories, have moved into the area since 1950, attracted by the ease of access, the availability of land, and the favorable attitude of the local authorities toward industry. The present growth trend in the town is expected to continue at such a rate that all usable land will be built over in the next 20 years. The expected completion early in 1965 of the extension of the Massachusetts Turnpike from Route 128 to downtown Boston will bring the Framingham area only 20 minutes driving time from the center of Boston.

The Saxonville portion of Framingham will be affected by the projected growth; its location close to the Massachusetts Turnpike is favorable to an acceleration in the present rapid buildup of housing in the area. For the project area, which is already completely built over, the effects of this growth will mean a change to commercial use for properties which are now occupied by obsolescent housing. The growth in the Cochituate Brook area across the river from the project site indicates recent flood history will not preclude investment. Eight new commercial establishments have been started in that area since the flood of August 1955.

The central location of the land at the project site, the network of roads connecting it to the surrounding residential districts, and the existing utilities make it prime land for commercial development. As the demand increases, the land will be more valuable for commercial development than for residences. The change-over will take place gradually over the next 20 years as present tenancy expires. An adjustment was made in the annual losses based on square foot losses for residential property as compared for square foot losses for commercial property in the area. The adjusted losses were discounted for the period of development using an interest rate of 3-1/8%. On the right bank of the river, the same trend in change of use can be expected coupled with a continued expanding use of presently vacant land. A similar adjustment in losses was made for this area.

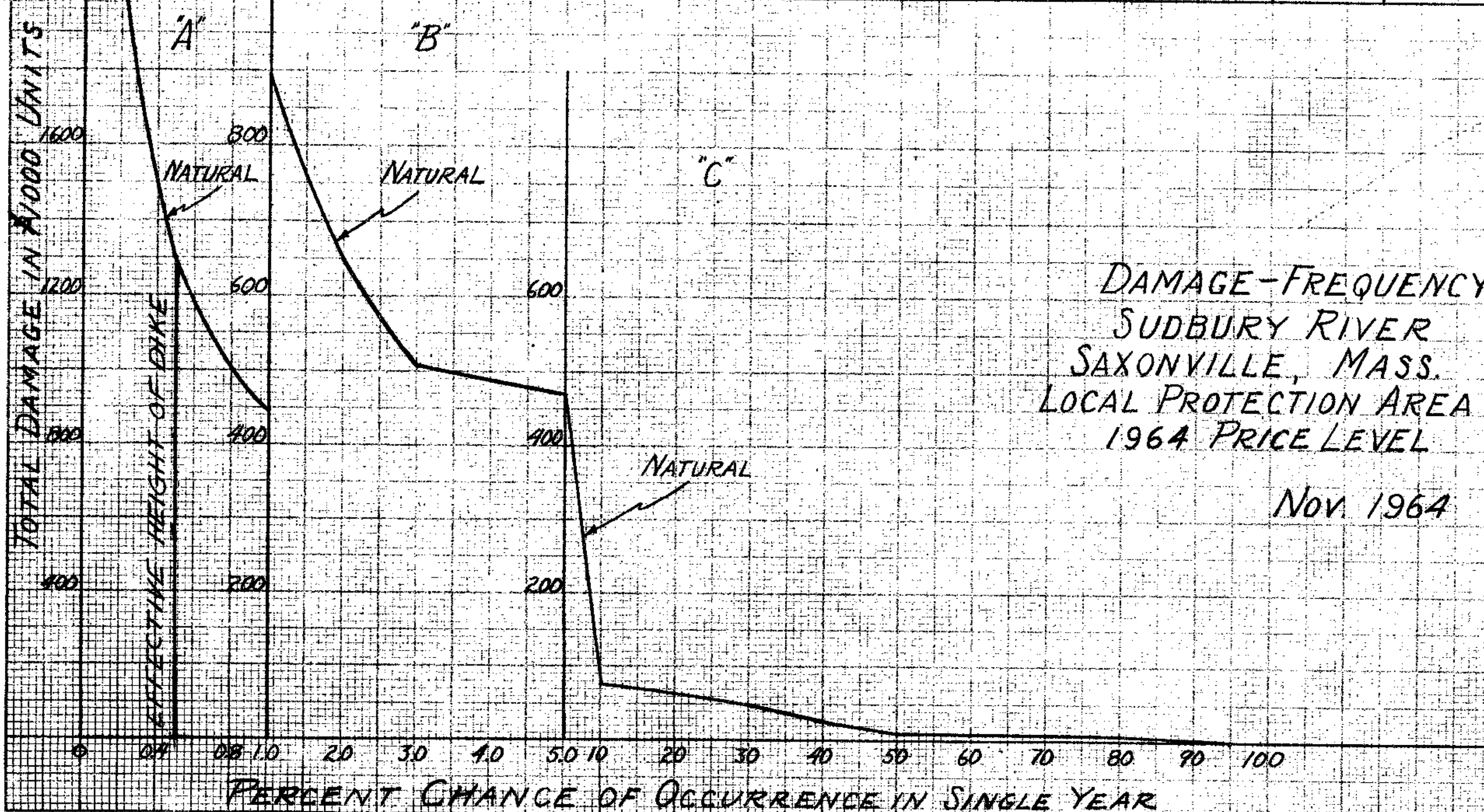
In addition to increased losses due to the change from residential to commercial use there will be industrial expansion in the prime land lying to the south of the present industrial area. With the normal ratio of building coverage to total area of one quarter to one fifth a 50,000 square foot industrial facility is probable in the area by 1970. Square foot annual loss and benefit data for present industrial facilities adjusted to reflect construction at somewhat higher floor elevations in light of the past floor record of the area were used to determine loss conditions in 1970. The higher floor level is at a sacrifice in plant efficiency. Annual losses and benefits for this industrial growth amount to $6,700 and $6,300 respectively. No discounting for time was made as it is unlikely that the protective works would be operative before 1970.

6. FLOOD DAMAGE PREVENTION BENEFITS

Tangible Benefits

Average annual flood damage prevention benefits were derived as the difference between annual losses expected in the area without flood protection and those remaining under conditions expected over the life of the project with construction of protective works to Standard Project Flood heights. Average annual benefits so derived amount to $65,000 under present conditions and $73,300 over the life of the project on the left bank. On the right bank, under current conditions, benefits to SPF protection would amount to $4,500 annually under current conditions, and $6,000 annually under future conditions.

	RANGE "A" 1 □" = $3200			RANGE "B" 1 □" = $4000			RANGE "C" 1 □" = $40,000			TOTAL ANNUAL	
	AREA	LOSS	BEN.	AREA	LOSS	BEN.	AREA	LOSS	BEN.	LOSS	BENEFIT
NATURAL	4.80	$15,400	$ —	5.80	$23,200	$ —	0.90	$36,000	$ —	$74,600	$ —
LOCAL PROTECTION	3.10	9,900	5,500	—	—	23,200	—	—	36,000	9,900	64,700



DAMAGE-FREQUENCY
SUDBURY RIVER
SAXONVILLE, MASS.
LOCAL PROTECTION AREA
1964 PRICE LEVEL

NOV. 1964

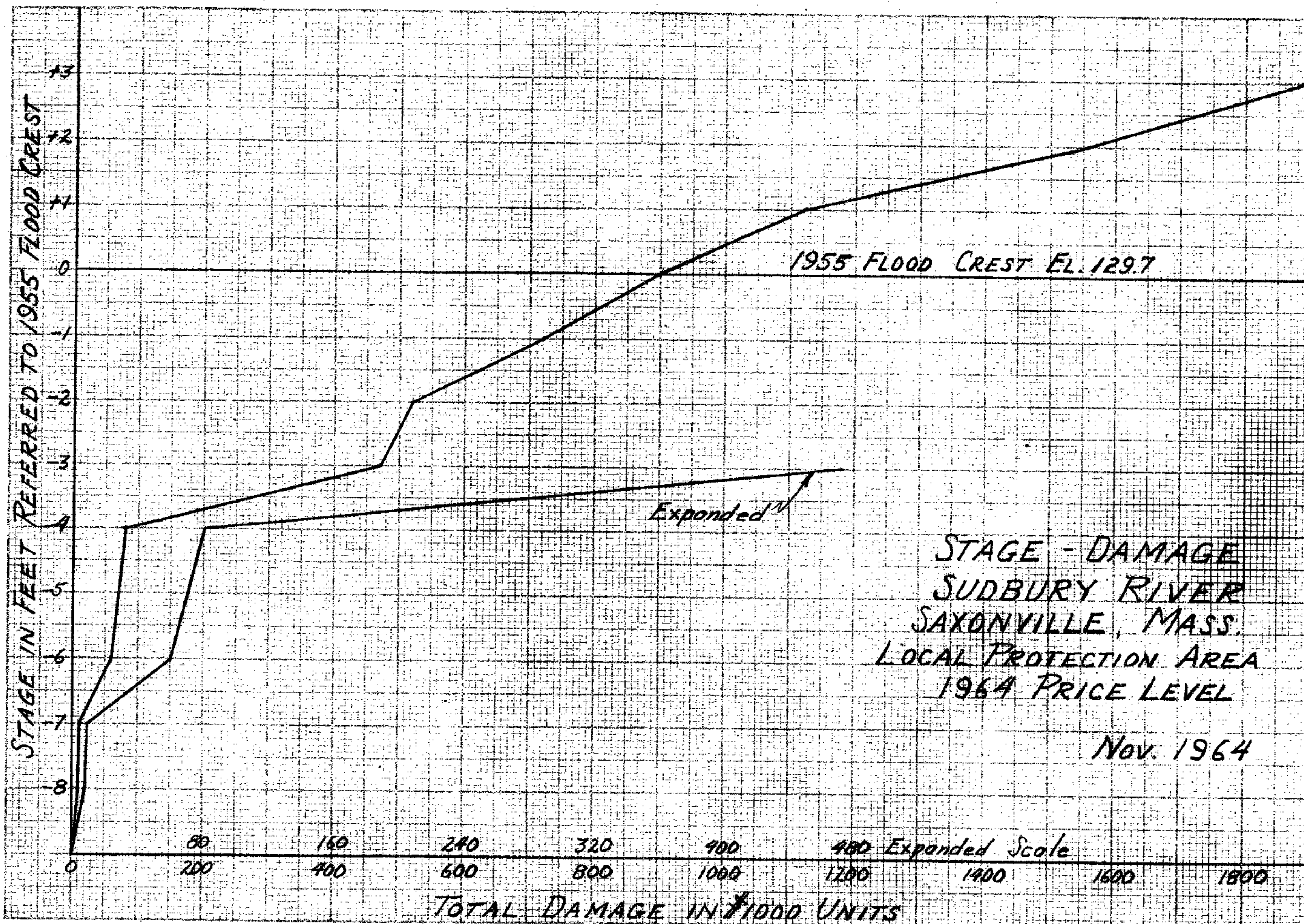

STAGE IN FEET REFERRED TO 1955 FLOOD CREST
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
-8
1955 FLOOD CREST EL. 129.7
Expanded
STAGE - DAMAGE
SUDBURY RIVER
SAXONVILLE, MASS.
LOCAL PROTECTION AREA
1964 PRICE LEVEL
NOV. 1964
80 160 240 320 400 480 Expanded Scale
0 200 400 600 800 1000 1200 1400 1600 1800
TOTAL DAMAGE IN $1000 UNITS

PLATE NO. B-2

APPENDIX C

PROJECT DESCRIPTION AND COSTS

APPENDIX C

PROJECT DESCRIPTION AND COSTS

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APPENDIX C

PROJECT DESCRIPTION AND COSTS

1. GEOLOGY

a. General. - Geologically, the site lies on the southern fringe of the bed of former Glacial Lake Sudbury, an immense silt, sand and gravel accumulation bounded and interrupted by glacial till hills, many of which are rock controlled. The area is drained by Sudbury River which follows a torturous northwesterly course from its origin in a rock and glacial till upland in Ashland, about 9 miles from Saxonville. It varies from a narrow marshy brook, partly ponded, near its source, to a substantial reservoir where it has been dammed about 4 miles upstream from the site, just west of Framingham Center. The river drops about 85 feet from its source to the site or, roughly, 10 feet/mile. The gradient is very flat for the next several miles, below Saxonville, and the Sudbury Valley to the north, (downstream) in Wayland and Sudbury, is typified by broad marshes and flood plain deposits. During increased runoff, wide areas downstream are inundated and the backwater reaches the base of a stone-faced mill dam resting on schist bedrock at the upstream limit of the proposed project. The average gradient above Saxonville is 10 feet/mile and below Saxonville 2 feet/mile, and the site can be said to lie, therefore, at the point of effective erosion, its rapids being the bedrock at the base of the existing dam. The area proposed for protection consists of the inside of a U-shaped river meander where the river, flowing from the west, has been deflected locally to the south by a clacial till hill which provides elevation closure for the proposed protection area. At the bottom of the U-meander, southward progress of the stream has been discouraged by the ice-contact slope of a glacial sand terrace 50 feet high, causing the river to resume its northerly course, passing east of the hill north of the meander and being restricted from travelling further east by the ice-contact slope of another high, glacial sand terrace.

The overburden throughout the flat area, while largely glacial silt and sand, has been disturbed during the development of the river meander, a temporary, hence unstable flood plain feature. The river undoubtedly has had several different courses locally and the bank at the southwestern end of the meander probably has been built as a series of concentric crescent-shaped bars, perhaps with mud fills in between and possibly with mud beneath. Considerable artificial fill has been built out on partly marshy meadows particularly near the river bank and most strikingly east and south of the lumber yard.

b. Site Investigations. - Site investigations consisted of field reconnaissance and foundation explorations. Fifteen drive-sample borings, six hand auger borings, one hand dug test pit, and thirty-five hand probings comprised the explorations. The locations and logs of the explorations are shown on Plates C-4 and C-5. Two borings made in 1932 by others for an existing WPA bridge at Concord Street also are shown.

2. PROJECT DESCRIPTION

a. General. - The recommended local protection project would be located along the left bank of the Sudbury River, extending from the Saxonville Pond Dam at Central Street to the Danforth Street bridge, a distance of about 3,800 feet. The plan of protection would provide for construction of 2,900 feet of earth dikes, 750 feet of concrete flood walls, 1,200 feet of channel relocation and improvement, a pumping station, a vehicular flood gate, a railroad stoplog structure, interior drainage and other appurtenant works. The project would provide protection for the land within the U-shaped bend of the river against the standard project flood. Project plans and details are shown on Plates No. C-1 to C-5 of this appendix.

b. Dike Design. - The dikes, in general, would have a top width of 12 feet and slopes of 1 on 2½ riverside and 1 on 2 landside as shown on Plate No. C-2. The major portion of the dikes would be constructed of compacted earth fill with slope protection consisting of 12 inches of protection stone on 12 inches of gravel bedding on the riverside and 6 inches of seeded topsoil on the landside. The project would be designed with a minimum of 3 feet of freeboard.

Excavated materials which are unsuitable for use in the dike or are in excess of the dike requirements could be spoiled in the area on the left (west) bank of the Sudbury River immediately downstream of the Danforth Street bridge. Permission to use the spoil area would be obtained from the owners by the Town of Framingham.

c. Flood Wall Design. - Concrete floodwalls would be designed in accordance with criteria established in EM 1110-2-2501, modified as necessary to fit local conditions. The floodwalls would consist of L-type, sloping base T-type and gravity type concrete walls. The heights of walls along the river edge would vary from 16 to 19 feet above the stream bed. The L-type concrete flood wall would be constructed along the riverside face of the existing mill building with a transitional change to a T-type concrete flood wall as the wall alignment angles away from the existing building. The concrete wall located north of Central Street and east of Saxonville Pond Dam would consist of sections of L, T and gravity type walls. At the downstream end of the project along Danforth Street, a gravity-type concrete wall would be constructed.

d. Channel Work. - Channel relocation and improvement would, in general, consist of relocating and straightening the existing channel so as to provide a straight dike alignment from the New York Central Railroad bridge to the Danforth Street bridge. The new channel would be trapezoidal in cross section with a 60-foot bottom width. Channel excavation depths would average about 6 feet with a maximum cut of 12 feet occurring at the existing earth mound located downstream of the confluence of Cochituate Brook with the Sudbury River.

e. Pumping Station. - A pumping station, for discharge of interior drainage, seepage and industrial waste water, would be located at the undeveloped southern end of the Roxbury Carpet Company property. The structure would house two axial flow pumps, each capable of discharging 10,500 gpm at a 17-foot static head. The pumps would be driven by two diesel engines through right-angle gear units. Normal runoff from approximately 35 acres of high ground and industrial waste water would be conducted to the Sudbury River through a 48-inch diameter, reinforced concrete pipe. During flood periods, interior drainage, seepage and industrial waste water would be pumped over the earth dike to the Sudbury River through two 20-inch diameter, coated steel pipes. The 48-inch gravity discharge pipe would be provided with a sluice gate on the riverside of the dike.

f. Vehicular Gate. - A vehicular flood gate closure would be required at the intersection of the project alignment and Concord Street. The closure would consist of two miter-type steel swing gate leafs about 7½ feet in height, hinged to concrete abutments. The gates when not in use, would be stored in the concrete abutments thereby providing a clear opening of 50 feet for vehicular traffic and sidewalks. In a closed or operating position the gate leafs would form a 60 degree angle with the centerline of Concord Street. The gate leafs in storage would be locked into the abutment cavities by means of bolts attached to clip angles set into the concrete and by a fixed jack which would also be utilized in the maintenance of the gate and hinges.

g. Stoplog Structure. - A stoplog closure would be required at the intersection of the project alignment and the New York Central Railroad spur track. The structure would be provided with a clear opening of 22 feet to permit passage of freight trains through the flood protected area during normal periods. Stoplogs would be provided to form a closure for flood waters in time of floods. Final design of the structure would be in cooperation with the railroad company. The closure would consist of stoplogs placed in slots of the concrete abutments at each end. When not in use, the stoplogs would be stored in a semi-portable metal constructed building located in close proximity to the stoplog structure.

h. Interior Drainage. - Construction of the recommended plan of protection would cause disruption of all interior drainage, drain lines, and industrial waste water which now discharge directly into the Sudbury River, thus necessitating the construction of an interceptor drain to the rear of the protective structure. The interceptor drain would conduct to the pumping station all interior runoff, industrial waste water, and seepage through the dikes and walls occurring during flood periods. In normal periods, waters from the interceptor drain line would pass by gravity flow to and through the pumping station and discharge line into the river. During flood periods, waters from the interceptor drain line at the pumping station would be diverted by sluice gates into the pumping inlet chamber and pumped over the dike to the river.

The interceptor drain line would be constructed of reinforced concrete pipe varying in size from 12-inches to 36-inches in diameter, Class III and V. Approximately 18 manholes and drain inlets would be required along the drain line and at the intersection of other pipe lines.

3. FOUNDATION CONDITIONS

a. General. - The structures in general will be built along an area of artificial fills with maximum thickness of about 10 feet, partly underlain by organic silts as thick as 4 feet; and also across a thin deposit of marshy materials involving minor stripping and, lastly, in the existing river bed itself which is underlain by alluvium up to 8 feet thick. All of these materials overlay glacial materials, largely glacial lake deposits, up to more than 40 feet thick; the principal exception being north of Sta. 0+50, where glacial till is at the surface and bedrock is very shallow, outcropping slightly farther upstream at the base of an existing mill dam.

The vertical distribution of materials is shown on Plate C-4, in an interpretive geologic section.

b. Concrete Structures. - Concrete floodwalls consist of an L-wall from Sta. 0+00 to Sta. 2+00 which will be founded on bedrock, and a T-wall from Sta. 2+00 to Sta. 6+28 which will be founded on glacial till and silty gravel.

The Concord Street flood gate will be founded on fairly loose, sandy, inorganic glacial silt at elevation 110' m.s.l., about 12 feet below ground surface and will be designed to tolerate slight movement owing to anticipated minor consolidation of foundation materials.

The railroad gate, Sta. 23+92 to Sta. 24+14, will be founded at or slightly below elevation 110' m.s.l., on rather loose, fine sandy, inorganic silt at excavation depths of approximately 13 feet, within what necessarily will be close shoring confines. Its design also will accommodate minor movement resulting from consolidation.

The pumping station will be founded about 5 feet below ground surface on loose, silty, gravelly sand.

c. Dikes. - A short upstream segment of the dike, from the wall wrap-around at Sta. 6+16 extending to Sta. 6+80 will have a ballasted toe in the river and will involve thin stripping of fill materials and cutting back of the slope largely in loose file materials which include rubble and some organic materials. The toe will rest on alluvium.

Downstream, from Sta. 6+80 to 19+50, all fill and organic materials will be excavated down to post-glacial alluvium or glacio-fluvial silts and sands. This will involve cuts about 5 feet deep, diminishing downstream to about 2 feet. A toe drain behind the dike, however, extends down to elevation 108' m.s.l., well down into the glacial materials, and will require excavation depths of nearly 15 feet, extending to below river level. Glacial till will be encountered in this trench, near the bottom of the cut, in the vicinity of Sta. 18+00.

Dikes downstream from Sta. 19+50 as far as the railroad bridge, will be placed on artificial fill with minor surface stripping. Downstream from the railroad bridge, however, the remaining dikes will be on thick fills and in the present river bed, and foundation preparation will involve stripping of fills, alluvium, and organic silt to depths ranging from a minimum of 2 feet to in excess of 7 feet. The tie-in end wall downstream is very low and will be partly on fill and partly on glacial till.

4. EMBANKMENT AND FOUNDATION DESIGN

a. General. - The surface deposits of alluvial fine sand and silt are for the most part loose and contain organic material. These surface materials (unified Soil Classification Symbol SM, ML and OL) are not considered suitable foundation materials and would have to be removed at structure locations. The underlying deposits of sands, sandy silt and gravels range in gradation from silty fine SAND (SP), gravelly silty SAND (SP-SM and SM), silty sandy GRAVEL (GP-GM and GW), sandy GRAVEL (GP) and sandy SILT (ML). These materials range from loose to moderately compact and are moderately to highly pervious, with extreme variations in permeability because of the heterogeneous nature of deposition. The stratified sand and silt in the glacial lake deposit between Stations 8+00 and 19+00, is moderately compact and relatively impervious consisting of silty fine SAND (SM), SILT (ML) and fine sandy SILT (ML), in horizontal strata of varying thicknesses.

b. Embankments. - Embankment heights average about 20 feet on the riverside and about 10 feet on the land side. Based on characteristics of the foundations and materials available for construction, an essentially homogeneous rooled earth fill section, with a top width of 12 feet and slopes of 1 on $2\frac{1}{2}$ riverside and 1 on 2 land side as shown on Plate No. C-2, has been selected. The embankment would be provided with a land side gravel fill section and toe drain for control of emerging seepage. Slope protection would be protection stone on gravel bedding on the riverside and seeded topsoil on the land side except for protection stone over the gravel drains. Unsuitable foundation materials within limits of the structures, including topsoil, surface deposits of weak and compressible silts and sands, trash and debris would be removed. Suitable materials from required excavations will be used as dumped fill on land side of the dike to provide additional ballast against possible uplift.

c. Foundations for Concrete Structures. - Foundations for concrete structures upstream of Sta. 8+00 will consist either of bedrock or moderately compact sand and gravel mixtures and foundation settlements are expected to be negligible. The concrete gate structures for Concord Street and for the railroad will be founded on a sandy silt foundation and a monolithic reinforced concrete base has been provided in its design to eliminate the detrimental effects of possible differential settlement by allowing the structure to settle as a complete single unit. Although permeability of the foundation sands and gravels is relatively high, it is considered that adequate seepage control will be provided by either concrete keys or wide base slabs where structures will be founded on overburden.

5. AVAILABILITY OF CONSTRUCTION MATERIALS

a. Earth Borrow. - Glacial till (gravelly, silty sand), suitable for construction of impervious fills is available at present in sufficient quantity from undeveloped areas within 3 to 5 miles of the site. Bank-run sand and gravel for construction of pervious fills, for gravel bedding, road gravel, and drainage fills are available from commercial sources within $1\frac{1}{2}$ to 5 miles of the site.

b. Rock Borrow. - There are two operating quarries, producing crushed stone aggregates, located within 10 miles of the site. Stone of the required sizes could be produced by these quarries. There also are several abandoned granite quarries in the Milford, Massachusetts area, about 15 miles from the site, which presently have waste piles from which suitable material could be obtained.

c. Concrete Materials. - There are thirteen commercial sources of concrete materials within a fifteen mile haul distance of the project site of which ten sources are processed sand and gravel and three sources are processed crushed stone. Of these sources, three have been previously tested and approved for Civil Works construction, but these sources are all located approximately a 15-mile haul distance to the site. In view of the relatively small amount of concrete required, ready-mix concrete will be permitted. There are ten sources of ready-mix concrete within a fifteen-mile haul distance to the project site and three of these sources presently use previously tested and approved aggregates, but these concrete sources are located approximately a 15-mile haul distance to the project.

6. REAL ESTATE

a. General. - Local interests would be required to provide all lands, easements and rights-of-way necessary for construction of the recommended project. Industrial, commercial and residential lands would be taken for the project.

b. Character of the Taking. - The barrier would start at a point on the northwest corner of Water and Central Streets on land now used as a dam to contain Saxonville Pond. It would consist of both an earthen dike and a concrete wall. It is assumed that the project would in no way interfere with the dam's operation. It is anticipated that no interference of the Roxbury Carpet Company's water rights or water requirements would result from the proposed project, and no loss of rights to continue these activities is expected. The project would then begin on the southerly side of Central Street in the river bed of the Sudbury River and along the west side of Roxbury Carpet Company mill building, in the form of a concrete wall which extends along the building for a distance of approximately 200 feet. At this point the wall would veer away from the building and follow the top of the river bank to a point near the southwest corner of the mill building. The barrier at this point would form an earthen dike and run generally along the river bank, traversing a paved parking lot and lands used for open storage and held for future expansion to a point approximately 200 feet west of Concord Street. Also to be located in this area would be a proposed pumping station which would be designed to eliminate natural pondage and drainage and/or industrial waste material from the plant's operation. The latter described alignment would be all on lands owned by the Roxbury Carpet Company and consist of about 5.9 acres of land of which 0.4 acre is in the river bed. Severance damage to this property is estimated to be $17,500 and the cost of land to be acquired amounts to $82,500.

Beginning again at a point about 200 feet west of Concord Street the earthen dike would cross a residentially improved property which would necessitate the acquisition of its entity. The estimated fair market value is $14,500 consisting of $12,500 for the improvements and $2,000 for the land.

The barrier would then cross Concord Street in the form of a vehicular gated structure and then pass over an improved residential lot in close proximity to the residence in the form of an earthen dike to a point along the west side of the New York Central Railroad right-of-way. Damages to this unit are estimated to be $5,000 severance damage and $2,000 for land to be acquired.

A stoplog structure would be constructed over the railroad right-of-way and then connect to an earthen dike which would traverse the Saxonville Lumber Company's storage area. The taking would result in a loss of value to the ownership by an estimated $10,000 in severance damage and $6,000 for land to be acquired.

At this point it is proposed to construct a new river channel over low unimproved land using sections of the present river bed to construct the earthen dike to a point about 400' south of Danforth Street. The barrier would then traverse the rear of the Saxonville Coal and Oil property in close proximity to their garage and the taking would include a concrete-enclosed fuel storage tank structure located near the river bank in the vicinity of Mechanic Street. Loss in value to the structure caused by the close proximity of the barrier is estimated to be $10,000 severance damage. Cost of lands to be acquired amounts to $7,300 and $5,000 for improvements.

The barrier would then proceed over the rear of an improved multi-residential lot and would include a small wooden framed utility shed and most of the clothes drying facilities. The barrier and project terminate at the southerly side of Danforth Street with the construction of a concrete wall extending about 100 feet from the river's edge. Severance damage to this property is estimated to be $3,000. The cost of land to be acquired amounts to $2,000 and the cost of improvements is $200.

c. Resettlement and Acquisition Costs. - It is proposed that the acquisition of all real estate interests required for the proposed area would be acquired by local interests; therefore, no funds to cover resettlement costs are included in this report. Acquisition costs are estimated at $5,000.

d. Estates to be Acquired. - It is recommended that all interests be acquired under easement, even though easement values commensurate fee values they would tend to reduce severance damages by allowing access to ownership remainders.

e. Evaluation. - The estimated values used in this report are based on the Market Data Approach. A search of the area was conducted to obtain comparable sales similar to the properties involved in the takings. Local assessors of the Town of Framingham were interviewed and sales and values were discussed.

Improved residential land values are based on lot sales of various sizes, terrain and location and the indicated average value is estimated to be about $5,000 per acre.

The unimproved marshy lands abutting the Sudbury River which are low and subject to occasional flooding are estimated at $1,000 per acre.

Improved industrial land values are based on recent similar sales in this general area and are estimated at $15,000 per acre.

All lands and interests would be acquired by local authorities, and therefore, the value of the Town-owned lands such as Concord and Danforth Streets are included in this report as a nominal value.

f. Summary. - Estimated value of lands and damages based on the plans provided for this preliminary real estate estimate total $170,000. It is considered desirable to include a contingency allowance of $15,000 in view of the lack of tract data and to provide for possible appreciation. The total estimated real estate cost is $185,000.

7. COST ESTIMATES

a. Basis of Estimate. - Topographic maps of the U. S. Army Map Service, to a scale of 1:25,000 with 10-foot contours, and U. S. Geological Survey Map, to a scale of 1:24,000 with 10-foot contours, were supplemented by plane table topographic and planimetric surveys of the studied dike alignments and adjacent topography. Foundation conditions were determined by field reconnaissance and foundation explorations. Quantities of the principal construction items were estimated on the basis of a preliminary design which would provide safe and adequate structures. Hydrologic and hydraulic criteria adopted for the design of dikes, flood walls, pumping station, and channel improvement are discussed in Appendix A. Benefits attributable to the plans are discussed in Appendix B.

Unit prices are based on average bid prices, adjusted to June 1964 price levels, for similar projects in the New England area.

b. Contingencies, Engineering and Overhead. - To cover contingencies, construction and relocation costs have been increased 20 percent. Costs of engineering, design, supervision, and administration are estimated lump sums based on knowledge of the project areas and experience on similar projects.

c. Apportionment of Costs. - In accordance with current policy, local interests will be required to pay for all lands, damages, and relocations, and to operate and maintain the project after completion.

Consideration was given to apportioning the cost of the pumping station with local interests to the extent of its use for the disposal of industrial waste water and the elimination of an existing ponding area. At the present time, the Roxbury Carpet Company discharges waste water directly into the river through the bottom floor of its building which extends out over the left bank. Construction of the concrete T-wall along the riverside face of this building would disrupt the waste water from flowing into the river, therefore necessitating the conduction of the waste water through the pumping station by way of the interceptor drain line. The quantity of industrial waste water amounts to about 1.5 c.f.s. or approximately 4% of the total 35 c.f.s. estimated to be pumped during flood periods. In addition, it is estimated that the elimination of the existing ponding area will effect a 3 c.f.s. increase in pumping capacity. Further details will be developed during final design stages to charge local interests for the increase in pumping capacity currently estimated at 4.5 c.f.s.

d. First Costs. - A detailed breakdown of first costs for the recommended project is shown in Table C-1 at the end of this appendix.

e. Annual Charges. - The estimate of Federal annual charges is based on interest at 3-1/8 percent on the Federal investment plus the amount required to amortize the investment over the assumed 50-year life of the project. The investment equals the Federal first cost since no interest charge accrues during the estimated construction period of one year. Non-Federal interest and amortization charges were computed in a similar manner at the same interest rate. Non-Federal charges also include amounts for maintenance and operation of the project, interim replacement of equipment having an estimated life of less than 50 years and an allowance for net loss of productivity of land. The derivation of annual charges is given in Table C-2 at the end of this appendix.

8. PROJECT FORMULATION

Annual benefits accruing to the project in the area to be protected are estimated to be $73,300. Annual costs are estimated at $64,700, resulting in a benefit-cost ratio of 1.1 to 1.

TABLE C-1

FIRST COST - SAXONVILLE LOCAL PROTECTION PROJECT
(June 1964 Price Level)

Item	Estimated Quantity	Unit	Unit Price	Estimated Amount	Total
Lands & Damages					
Lands & Improvements	1	Job	L.S.	$170,000	
Contingencies				15,000	
Total Lands & Damages					$185,000
Relocations					
Utilities	1	Job	L.S.	$ 3,500	
Contingencies				700	
Engineering & Design				500	
Supervision and Administration				300	
Total Relocations					5,000
Channels & Canals					
Excavation	16,000	C.Y.	$1.50	$ 24,000	
Contingencies				5,000	
Engineering & Design				4,000	
Supervision and Administration				2,000	
Total Channels & Canals					35,000
Levees & Floodwalls					
Site Preparation	1	Job	L.S.	10,000	
Stream Control	1	Job	L.S.	20,000	
Land Dikes					
Excavation, unclassified	42,000	c.y.	1.00	42,000	
Compacted Earth Fill	67,300	c.y.	2.00	134,600	
Compacted Gravel Fill	13,000	c.y.	2.50	32,500	
Gravel Bedding	4,600	c.y.	2.50	11,500	
Protection Stone	8,200	c.y.	7.00	57,400	
Dumped Fill	14,000	c.y.	0.50	7,000	
Topsoil and Seeding	7,000	s.y.	1.00	7,000	
Sub-Total Land Dikes				$292,000	

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TABLE C-1 (Cont.)

Item	Estimated Quantity	Unit	Unit Price	Estimated Amount	Total
Flood Walls					
Structural Excavation	9,000	c.y.	$1.50	$13,500	
Sheeting & Bracing	1	Job	L.S.	5,000	
Earth Backfill	7,400	c.y.	4.00	29,600	
Reinforced Concrete	3,100	c.y.	70.00	217,000	
Mass Concrete	160	c.y.	40.00	6,400	
Shoring Mill Bldg.	1	Job	L.S.	30,000	
Misc. Work	1	Job	L.S.	4,500	
Sub-Total Flood Walls				$306,000	
Vehicular Gate					
Structural Excavation	1,200	c.y.	1.50	$ 1,800	
Earth Backfill	900	c.y.	4.00	3,600	
Reinforced Concrete	440	c.y.	70.00	30,800	
Steel Gate	1	Job	L.S.	11,000	
Pavement	450	s.y.	4.00	1,800	
Misc. Items	1	Job	L.S.	1,000	
Sub-Total Vehicular Gate				$ 50,000	
Stoplog Structure					
Structural Excavation	800	c.y.	1.50	$ 1,200	
Earth Backfill	650	c.y.	4.00	2,600	
Reinforced Concrete	160	c.y.	70.00	11,200	
Sheeting & Bracing	1	Job	L.S.	5,000	
Maintaining Traffic	1	Job	L.S.	6,000	
Stoplog Shelter	1	Job	L.S.	3,000	
Sub-Total Stoplog Structure				$ 29,000	
Drainage					
Trench Excavation	4,000	c.y.	1.00	$ 4,000	
Earth Backfill	3,000	c.y.	3.00	9,000	
Sheeting & Bracing	1	Job	L.S.	7,500	
12" R.C. Pipe	50	L.F.	3.00	150	
15" R.C. Pipe	150	L.F.	4.00	600	
24" R.C. Pipe	300	L.F.	7.00	2,100	
30" R.C. Pipe	700	L.F.	10.00	7,000	
36" R.C. Pipe	1,600	L.F.	13.00	20,800	

TABLE C-1 (Cont.)

Item	Estimated Quantity	Unit	Unit Price	Estimated Amount	Total
Manholes	9	Each	600.00	$ 5,400	
Drain Inlets	9	Each	400.00	3,600	
Headwall	1	Job	L.S.	850	
Seepage Control	1	Job	L.S.	5,000	
Misc. Items	1	Job	L.S.	2,000	
Sub-Total Drainage				$ 68,000	
Contingencies				155,000	
Engineering & Design				116,000	
Supervision & Administration				74,000	
Total Levees and Floodwalls					$1,120,000
Pumping Plants					
Pumping Station					
Structural Excavation	300	c.y.	1.50	450	
Earth Backfill	150	c.y.	4.00	600	
Reinforced Concrete	200	c.y.	70.00	14,000	
Superstructure	1	Job	L.S.	25,000	
Pumps and Engines	2	Each	13,500	27,000	
Sluice Gates	2	Each	5,000	10,000	
Traveling Crane	1	Job	L.S.	2,200	
20" Discharge Pipes	260	L.F.	40.00	10,400	
48" Discharge Pipes	125	L.F.	40.00	5,000	
Electrical Work	1	Job	L.S.	2,000	
Misc. Items	1	Job	L.S.	3,350	
Sub-Total Pumping Station				$100,000	
Contingencies				20,000	
Engineering & Design				15,000	
Supervision & Administration				10,000	
Total Pumping Plants					145,000
TOTAL PROJECT FIRST COST					$1,490,000

Note: The above estimate does not include preauthorization study costs of $30,000.

TABLE C-2

ANNUAL CHARGES

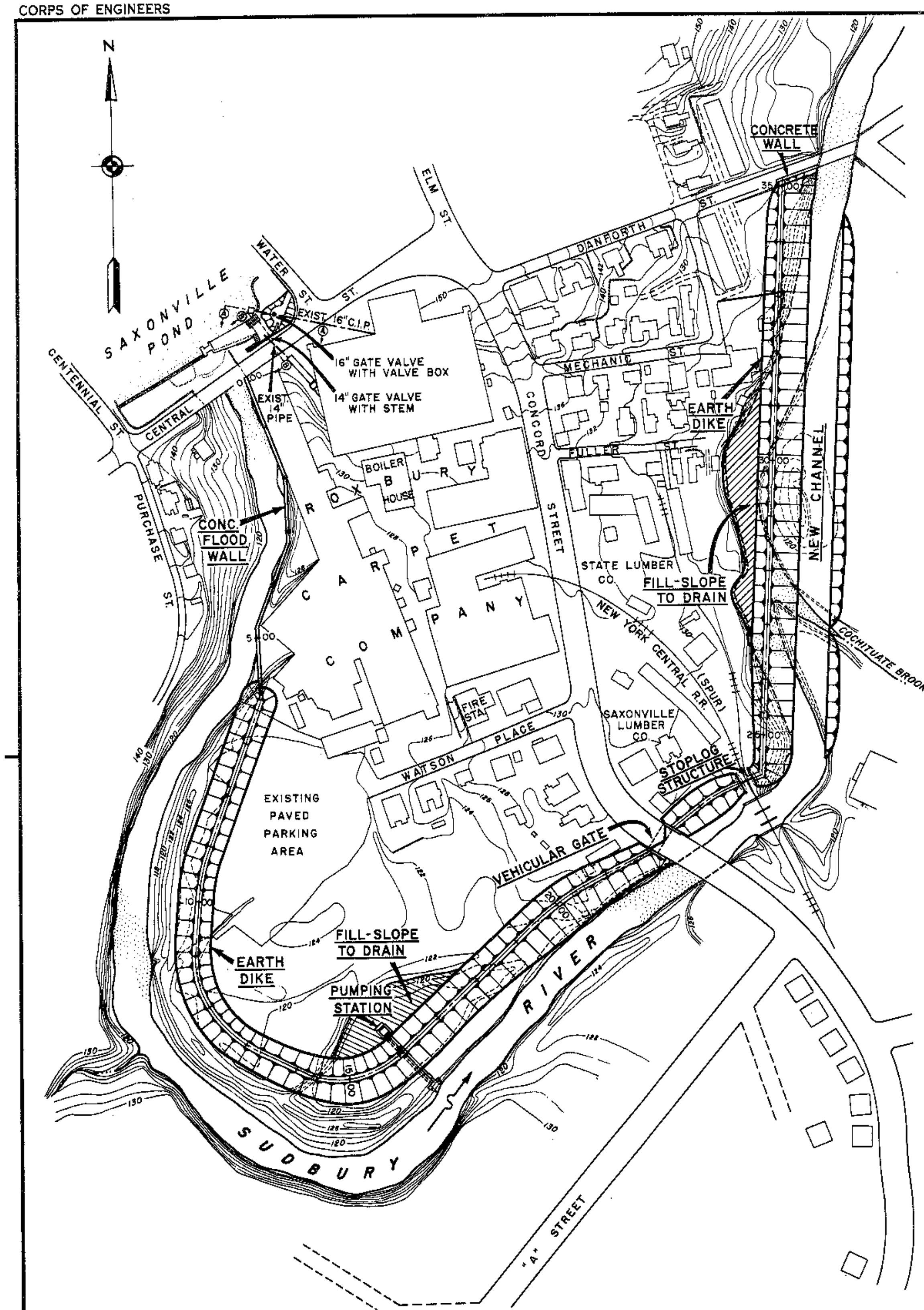
SAXONVILLE LOCAL PROTECTION PROJECT
(50-year Life)

Federal Annual Costs			
Interest	(.03125 x $1,300,000)	= $40,600	
Amortization	(.00854 x $1,300,000)	= 11,100	
Total Federal Annual Cost			$51,700
Non-Federal Annual Costs			
Interest	(.03125 x $ 190,000)	= $ 5,900	
Amortization	(.00854 x $ 190,000)	= 1,600	
Maintenance & Operation		2,500	
Interim Replacements		1,500	
Loss of Productivity of Land		1,500	
Total Non-Federal Annual Cost			13,000
TOTAL ANNUAL CHARGES			$64,700

R 4/16/65

CORPS OF ENGINEERS

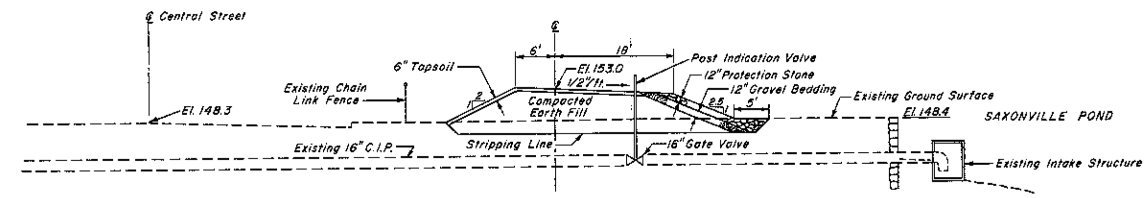
U. S. ARMY



GENERAL PLAN

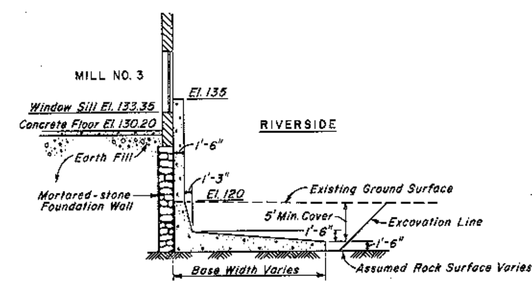
SCALE IN FEET

1" = 100'-0" 100' 0 100' 200'



SECTION A-A

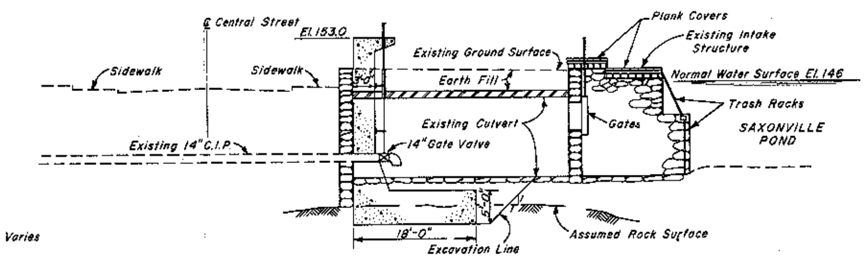
SCALE: 1" = 10'



TYPICAL SECTION L-TYPE FLOODWALL

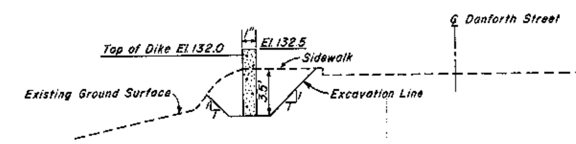
STA. 0+00 TO STA. 2+00

SCALE: 1" = 10'



SECTION B-B

SCALE: 1" = 10'



TYPICAL SECTION

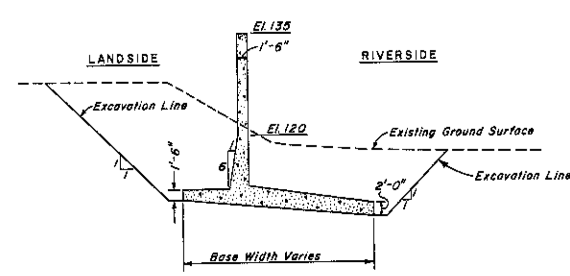
CONCRETE WALL AT DANFORTH STREET

SCALE IN FEET

1" = 5'-0" 5' 0 5' 10'

NOTES:

1. Topography shown is from survey by the Corps of Engineers with two-foot contour interval.
2. Elevations are in feet and refer to mean sea level datum.



TYPICAL SECTION T-TYPE FLOODWALL

STA. 2+00 TO STA. 6+28

SCALE IN FEET

1" = 10'-0" 10' 0 10' 20'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY	TR. BY	CK. BY
W.J.W.	M.S.	

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION
GENERAL PLAN AND SECTIONS
SUDBURY RIVER MASSACHUSETTS

C. H. Ciriello
PROJECT ENGINEER
CHIEF, SMALL PROJ. SECTION
SUBMITTED BY
CHIEF, PLANN. & RPTS. BRANCH
APPROVED
CHIEF, ENGINEERING DIVISION
DATE FEB. 1965

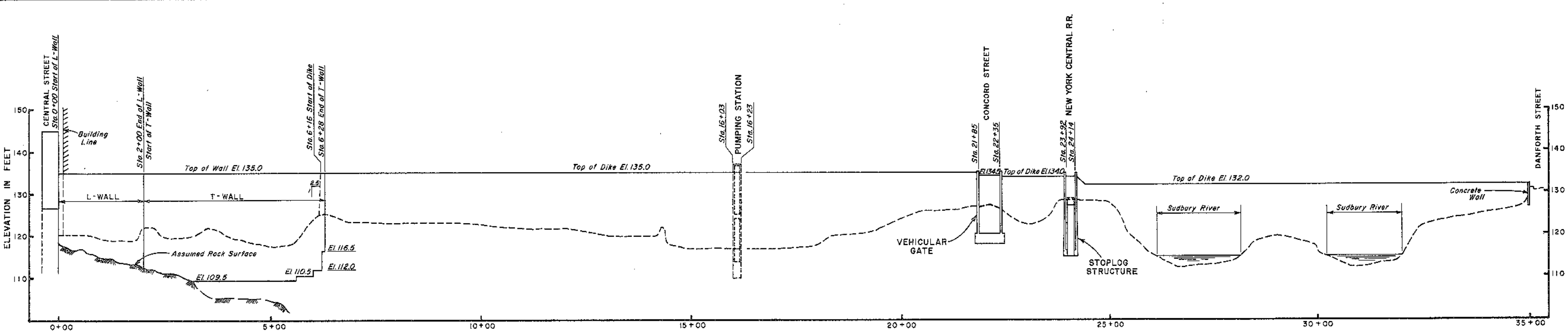
TO ACCOMPANY REPORT DATED 26 FEB. 1965

SCALE: AS SHOWN

DRAWING NUMBER

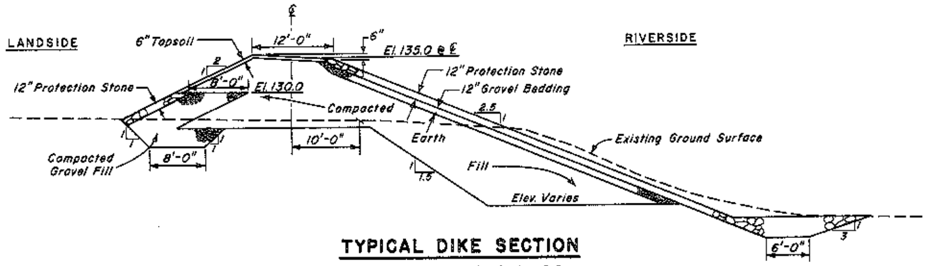
SHEET

PLATE NO. C-1



PROFILE ALONG ℄ WALL AND DIKE

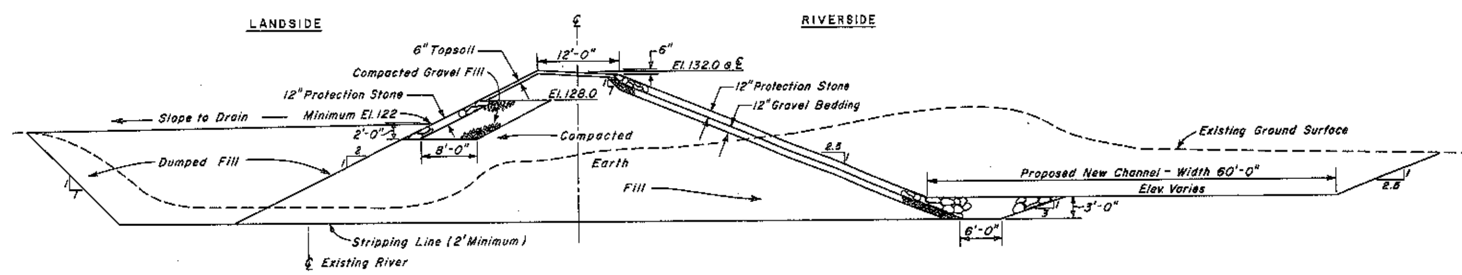
SCALE: HORIZ.: 1" = 100'
VERT.: 1" = 10'



TYPICAL DIKE SECTION

STA. 6+16 TO STA. 6+80
AND
STA. 19+50 TO STA. 21+80

SCALE: 1" = 10'



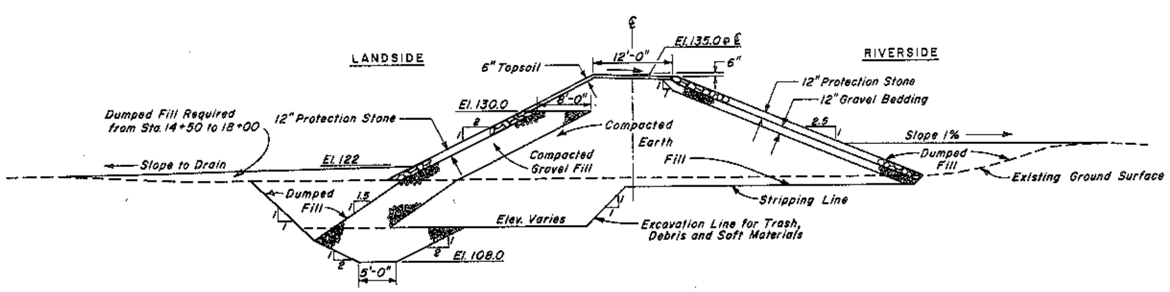
TYPICAL DIKE SECTION

STA. 24+28 TO STA. 35+0

SCALE: 1" = 10'

NOTES:

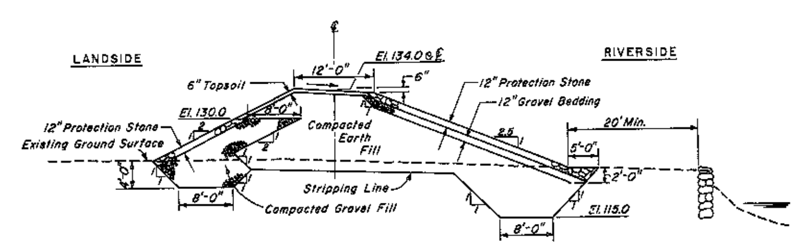
1. Elevations are in feet and refer to mean sea level datum



TYPICAL DIKE SECTION

STA. 6+80 TO STA. 19+50

SCALE: 1" = 10"



TYPICAL DIKE SECTION

STA. 22+39 TO STA. 23+87

SCALE IN FEET

1" = 10'-0" 10' 0 10' 20'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY W.J.W. | TR. BY M.S. | CK. BY

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS

SAXONVILLE LOCAL PROTECTION
PROFILE AND SECTIONS

SUDBURY RIVER — MASSACHUSETTS

PROJECT ENGINEER
CHIEF, SMALL PROJ. SECTION
SUBMITTED BY
CHIEF, PLANN. & RPT'S BRANCH
APPROVED
CHIEF ENGINEERING DIV.

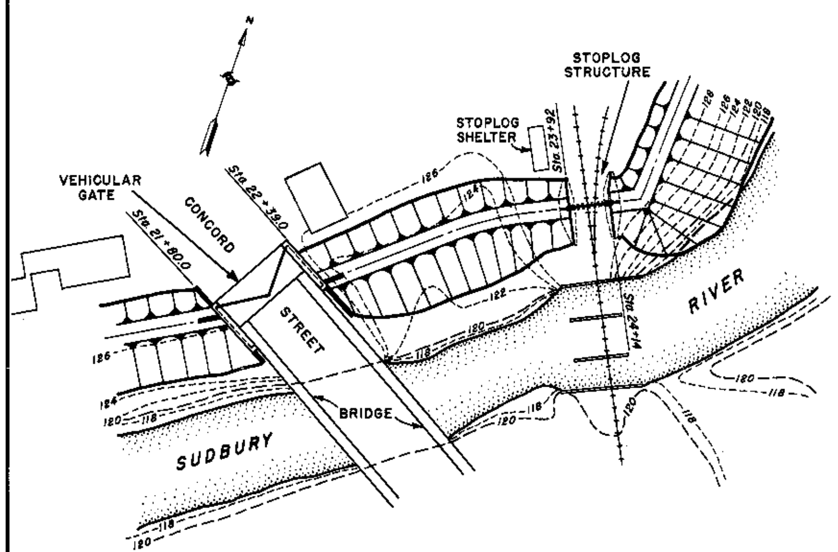
DATE FEB. 1965

SCALE: AS SHOWN

DRAWING NUMBER

SHEET

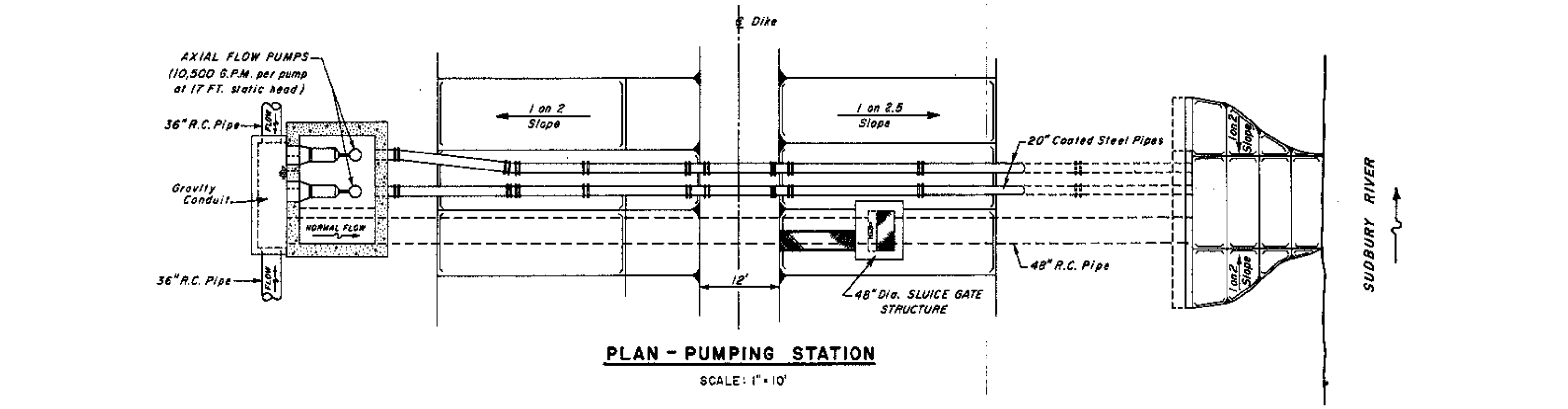
TO ACCOMPANY REPORT
DATED: 26 FEB. 1965



GENERAL PLAN - CLOSURE STRUCTURES

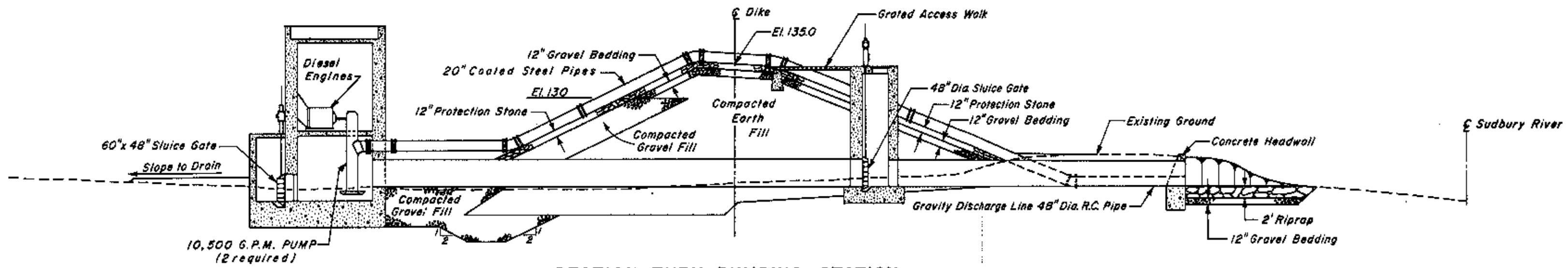
SCALE IN FEET

1" = 40'-0"



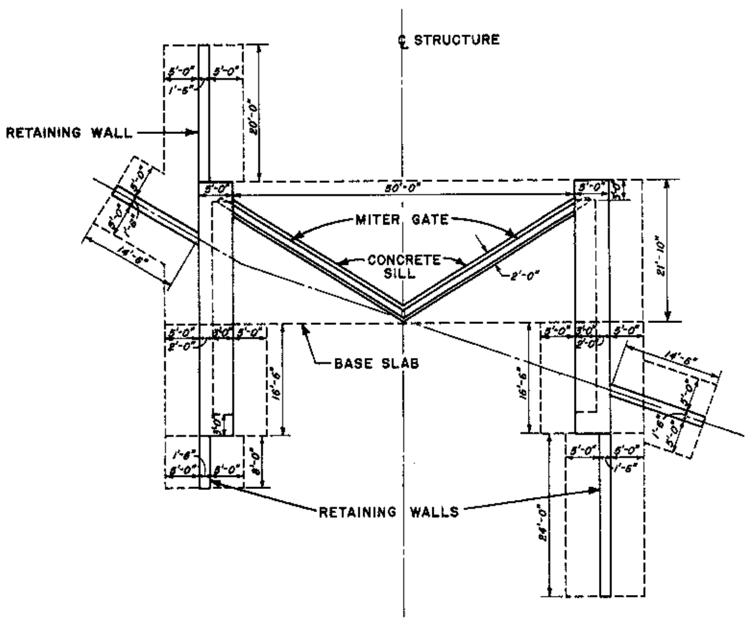
PLAN - PUMPING STATION

SCALE: 1" = 10'



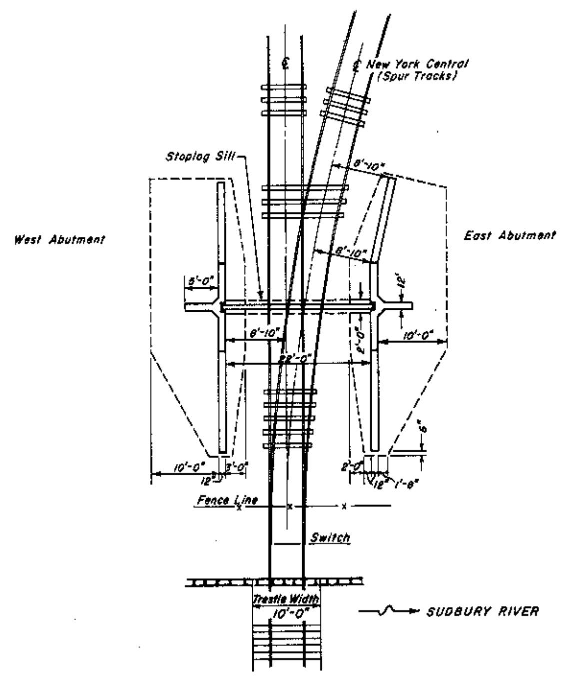
SECTION THRU PUMPING STATION AND DISCHARGE LINES

SCALE: 1" = 10'



PLAN - CONCORD STREET VEHICULAR GATE

SCALE: 1" = 10'



PLAN - STOPLOG STRUCTURE

SCALE IN FEET

1" = 10'-0"

NOTES:

1. Elevations are in feet and refer to mean sea level datum

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DR. BY W.J.W. TR. BY M.S. CK. BY

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS

SAXONVILLE LOCAL PROTECTION
SECTIONS AND DETAILS

SUDBURY RIVER MASSACHUSETTS

PROJECT ENGINEER
CHIEF, PROJ. SECTION
SUBMITTED BY
CHIEF, PLANNING & REPTS BRANCH
APPROVED
CHIEF ENGINEERING DIV.

DATE FEB. 1965

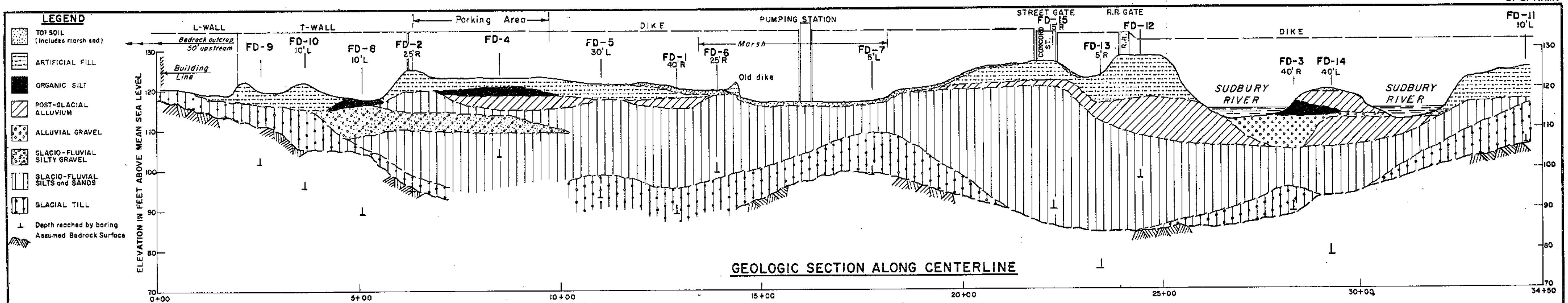
SCALE: AS SHOWN

DRAWING NUMBER

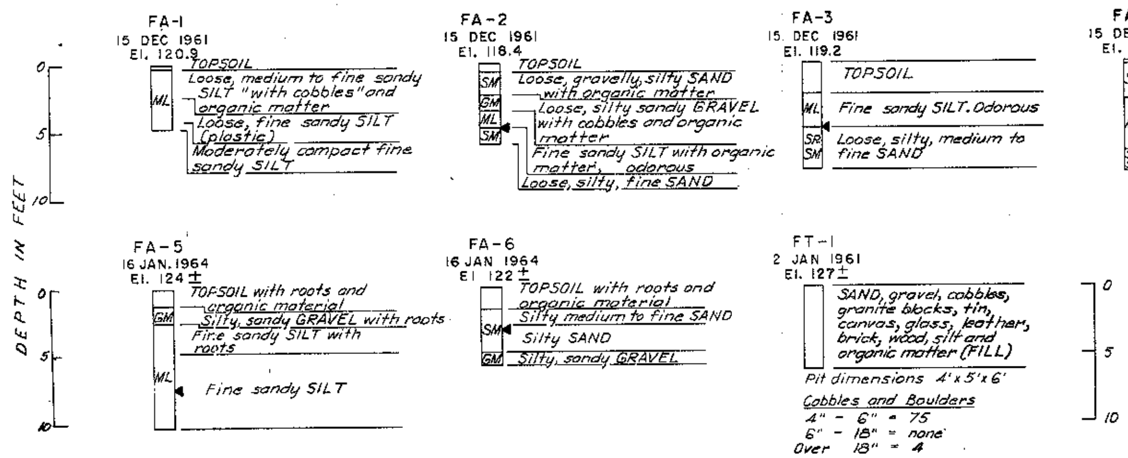
SHEET

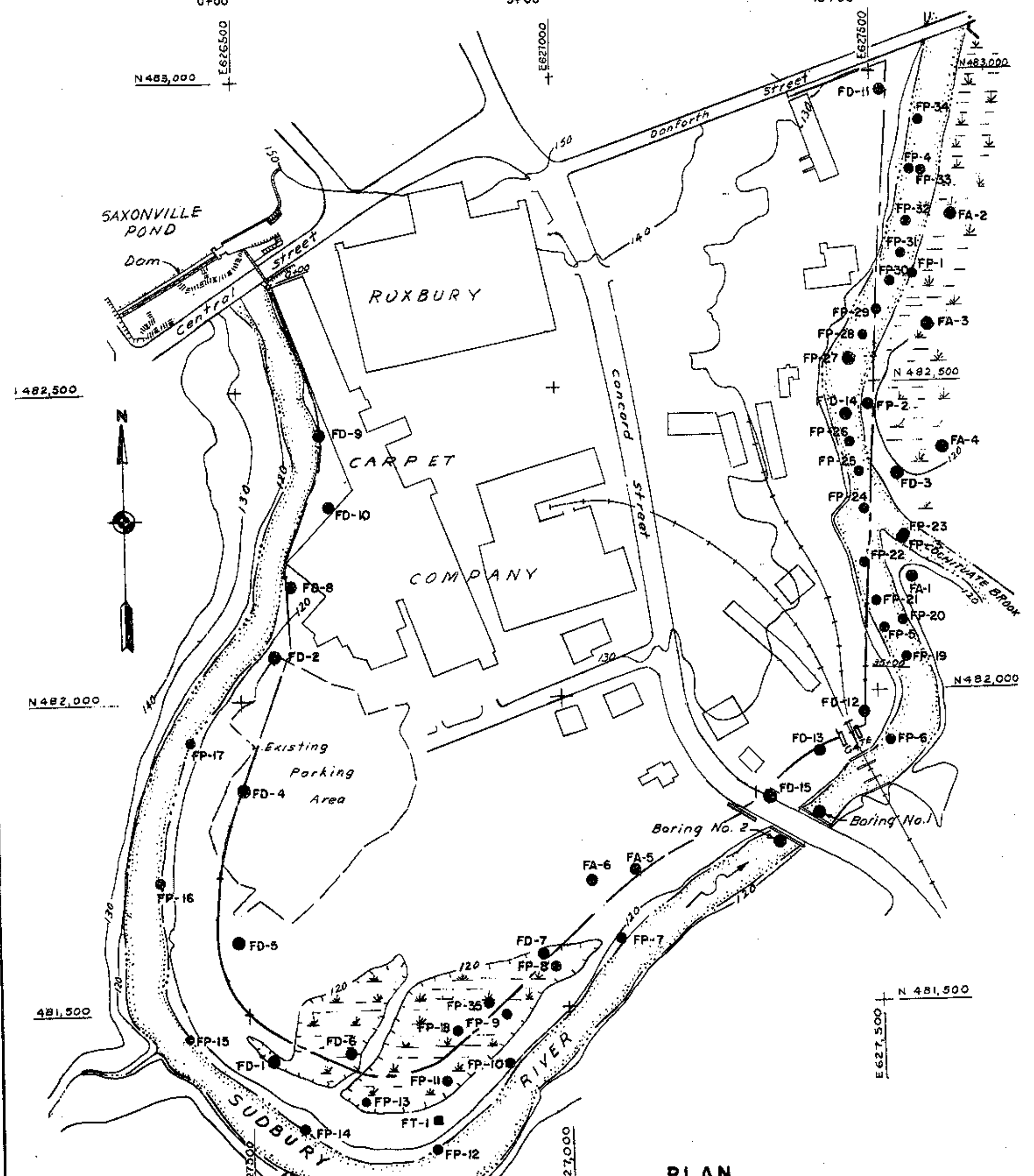
TO ACCOMPANY REPORT
DATED: 26 FEB. 1965

PLATE NO. C-3



GEOLOGIC SECTION ALONG CENTERLINE





PLAN
SCALE: 1" = 100

PROBING TABLE

FP NO.	TOP ELEV.	PUSHED PENETRATION WEIGHT OF 1 MAN	PUSHED PENETRATION WEIGHT OF 2 MEN	DEPTH RANGE HAMMER'D	HAMMERED PENETRATION DEPTHS & BLOWS/FT (8# HAMMER) 1st	2nd	3rd	4th	5th	6th	7th	8th
1	118.7	0.0 - 1.8	1.8 - 2.1	2.1 - 9.8	3/0.9	6	9	10	12	18	20	36/0.8
2	119.6	0.0 - 3.5	-	3.5 - 9.2	51/0.5	62	50	18	17	23	24/0.2	* -
3	114.7	0.0 - 2.3	-	2.3 - 3.5	37/0.7	38/0.5	* -	-	-	-	-	-
4	114.6	0.0 - 1.4	1.4 - 3.0	3.0 - 5.8	18	25	37/0.8	* -	-	-	-	-
5	114.8	0.0 - 2.0	-	2.0 - 4.3	12	25	35/0.5	* -	-	-	-	-
6	115.3	0.0 - 1.3	-	1.3 - 4.5	21/0.7	17	13	30/0.5	-	-	-	-
7	117.1	0.0 - 2.8	2.8 - 3.0	3.0 - 6.3	23	25	37	42/0.3	-	-	-	-
8	118.2†	0.0 - 1.0	-	1.0 - 4.7	10	36	48	46/0.7	-	-	-	-
9	118.2†	0.0 - 3.0	-	3.0 - 6.4	15	22	40	52/0.4	* -	-	-	-
10	121.1	0.0 - 3.5	-	3.5 - 6.3	15/0.5	22	40	52/0.3	-	-	-	-
11	117.9	0.0 - 1.3	-	1.3 - 7.4	10/0.7	8	10	12	27	30	45/0.4	-
12	115.8	0.0 - 3.1	-	3.1 - 5.8	11/0.9	14	25/0.8	* -	-	-	-	-
13	117.9	0.0 - 1.3	-	1.3 - 7.5	8/0.7	12	17	19	26	27	30/0.5	-
14	116.5	0.0 - 1.4	-	1.4 - 6.6	5/0.6	7	8	21	20	25/0.8	-	-
15	116.1	0.0 - 2.7	-	2.7 - 8.8	8/0.3	15	15	32	30	16	22/0.8	-
16	115.8	0.0 - 2.0	-	2.0 - 8.5	12	17	18	47	42	35	55/0.5	-
17	116.7	0.0 - 1.1	-	1.1 - 2.8	11/0.9	48/0.8	* -	-	-	-	-	-
18	117.7†	0.5 - 1.0	1.0 - 4.2	4.2 - 5.2	64	-	-	-	-	-	-	-
19	113.7	0.0 - 0.1	0.1 - 0.2	0.2 - 1.2	50/0.8	39/0.2	-	-	-	-	-	-
20	113.9	0.0 - 0.3	0.3 - 0.4	0.4 - 1.4	28/0.6	30/0.4	-	-	-	-	-	-
21	113.6	0.0 - 0.4	-	0.4 - 1.4	60/0.5	40/0.4	-	-	-	-	-	-
22	113.4	0.0 - 0.2	0.2 - 0.4	0.4 - 1.4	30/0.6	33/0.4	-	-	-	-	-	-
23	115.0	0.0 - 0.7	-	0.7 - 1.7	51/0.3	60/0.7	-	-	-	-	-	-
24	113.5	-	0.0 - 0.2	0.2 - 1.2	52	-	-	-	-	-	-	-
25	113.1	0.0 - 0.2	0.2 - 1.0	1.0 - 2.0	65	-	-	-	-	-	-	-
26	113.1	0.0 - 0.5	-	0.5 - 1.5	15/0.5	11/0.6	-	-	-	-	-	-
27	113.2	0.0 - 0.7	-	0.7 - 2.7	38	47	-	-	-	-	-	-
28	113.2	0.0 - 0.1	0.1 - 0.4	0.4 - 2.5	41/0.6	30	50/0.5	-	-	-	-	-
29	112.9	0.0 - 0.8	-	0.8 - 1.8	48	-	-	-	-	-	-	-
30	113.1	0.0 - 0.5	0.5 - 1.1	1.1 - 2.1	77	-	-	-	-	-	-	-
31	113.5	0.0 - 0.2	0.2 - 0.4	0.4 - 1.4	45	-	-	-	-	-	-	-
32	113.8	0.0 - 0.2	0.2 - 0.3	0.3 - 1.3	45	-	-	-	-	-	-	-
33	113.8	0.0 - 0.2	0.2 - 0.3	0.3 - 1.3	50	-	-	-	-	-	-	-
34	113.6	-	-	0.0 - 1.0	56	-	-	-	-	-	-	-
35	117.7†	0.5 - 2.0	2.0 - 4.3	4.3 - 5.3	60	-	-	-	-	-	-	-

* Indicates refusal.

FP-18 and FP-35 "Drove "E" Rod through ice 0.0 -0.5
Fractional foot of penetration thus:
blow per foot per tenths of a foot (25/0.6)

† Elevation taken on ice.

GRAPHIC SCALE
100' 0 100' 200'
1" = 100'

LEGEND

- ● FD Foundation Test Boring
- ● FA Foundation Hand Auger Boring
- ■ FT Foundation Test Pit
- ● FP Foundation Probing
- Bedrock Outcrop
- Marsh

NOTES

Elevations are in feet and refer to Mean Sea Level
Coordinates refer to Massachusetts Lambert Grid System
Boring No.1 and Boring No.2 made by others, for WPA, dated 12 July 1932, believed to refer to Mean Sea Level
Figures in columns on Borings No.1 and 2 indicate blows per foot on spoon (weight of hammer assumed to be 140# with 30" free fall.)
Contour interval is 10 feet.
Probings FP-1 through FP-17 taken Dec. 1961, FP-18 through FP-35 - Jan. 1964.

Additional Record of Explorations is on Plate No C-5

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.G.H. | DR. BY R.A.W. | CK. BY R.C.G.
SUBMITTED M.C. Gunley — CHIEF, GEOLOGY SECTION
PROJECT ENGINEER C.H. Cirulla
APPROVAL RECOMMENDED — CHIEF, FDN. & MAT'LS BRANCH
APPROVAL RECOMMENDED — CHIEF, PLANN. & RPTS BRANCH

MERRIMACK RIVER FLOOD CONTROL
FRAMINGHAM, MASSACHUSETTS
SAXONVILLE LOCAL PROTECTION
PLAN AND RECORD OF EXPLORATIONS
SUDBURY RIVER MASSACHUSETTS

APPROVED — CHIEF, ENGINEERING DIVISION
DATE FEB. 1965

SCALE AS SHOWN
DRAWING NUMBER
SHEET

TO ACCOMPANY REPORT
DATED: 26 FEB 1965

CORPS OF ENGINEERS

U. S. ARMY

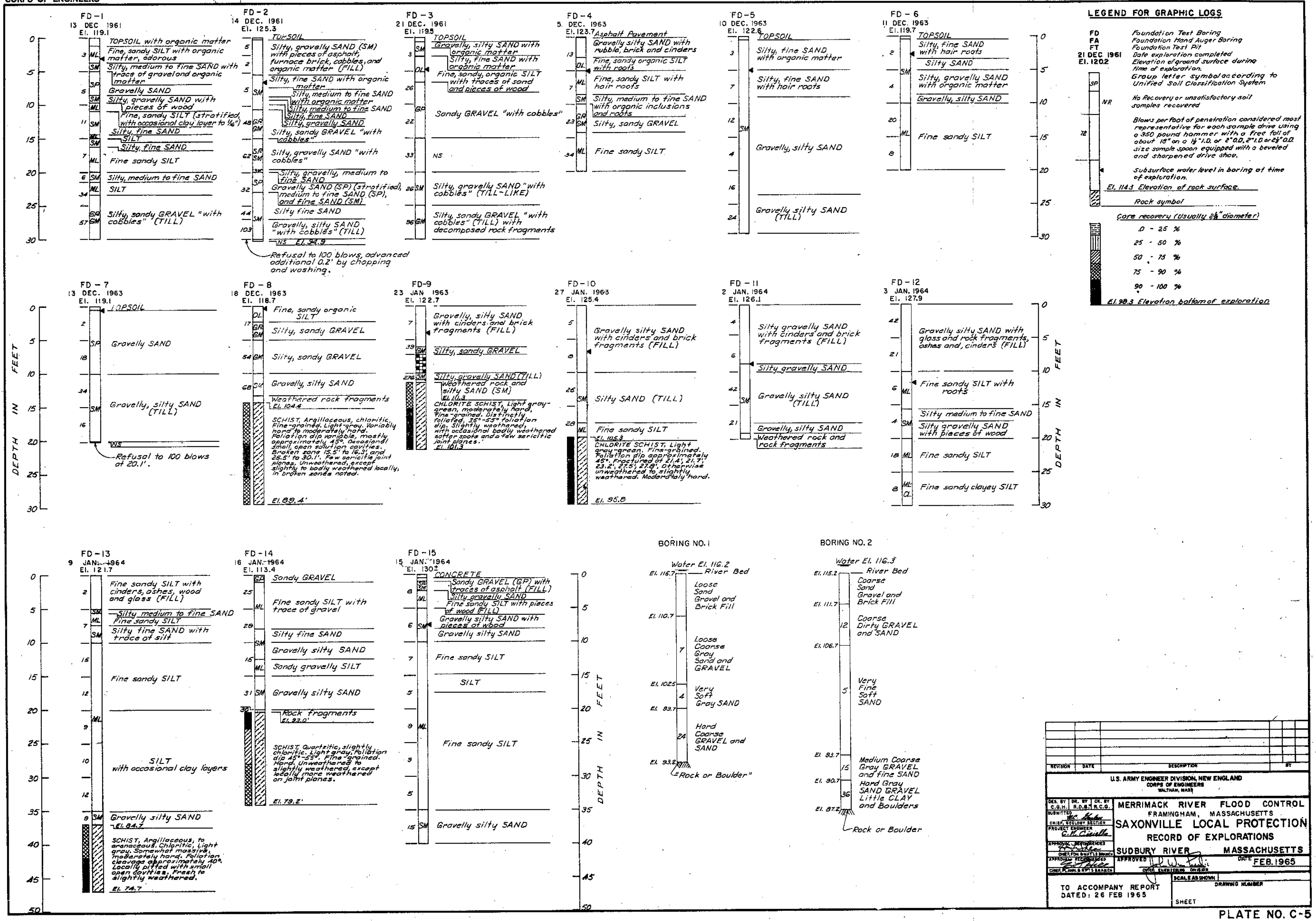


PLATE NO. C-5

APPENDIX D

LETTERS OF COMMENT AND CONCURRENCE

APPENDIX D

LETTERS OF COMMENT AND CONCURRENCE

TABLE OF CONTENTS

Exhibit No.	Agency	Letter Dated
D-1	Massachusetts Water Resources Commission	18 Feb. 1965
D-2	Town of Framingham	21 Jul. 1964
D-3	Town of Framingham	1 Apr. 1963
D-4	U. S. Department of Health, Education and Welfare	30 Dec. 1964
D-5	U. S. Department of Agriculture Soil Conservation Service	16 Mar. 1964
D-6	U. S. Department of Interior Fish and Wildlife Service	22 May 1962

The Commonwealth of Massachusetts
Water Resources Commission

OFFICE OF THE DIRECTOR

15 SCHOOL STREET, BOSTON 02108

February 18, 1965

Colonel Edward Ribbs
Acting Division Engineer
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Sir:

This Commission has reviewed the proposed Saxonville Local Protection project. In view of the change from a 685 project to one of more than a million dollars requires Congressional approval.

The change in status of this project meets with the approval of this Commission.

Very truly yours,

Malcolm E. Graf

Malcolm E. Graf
Director and Chief Engineer

MEG:im

OFFICE OF THE DIRECTOR

The Commonwealth of Massachusetts

Water Resources Commission

73 Tremont Street, Boston 8

August 14, 1962

John Wm. Leslie, Chief
Engineering Division
U. S. Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

RE: Sudbury River Flood Control Project in Saxonville.

Dear Mr. Leslie:

This office is in receipt of your letter of June 25, 1962, enclosing a description and preliminary plans for the Saxonville local flood protection project in the Town of Framingham, Massachusetts.

The project was reviewed by this Commission at its meeting on August 13, 1962, and the Commission concurred with the proposed project as shown on the preliminary plans and believes that the project would be very beneficial towards providing flood protection along the Sudbury River in the Saxonville Section of the Town of Framingham.

Very truly yours,

C. I. Sterling Jr.

Clarence I. Sterling, Jr.
Director and Chief Engineer

CIS/n

Town of Framingham

Massachusetts

Selectmen's Office

ELBERT TUTTLE, Chairman
PERRY H. HENDERSON, Clerk
WILLIAM D. OLESON

July 21, 1964

Brigadier General P. C. Hyzer, Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

Dear General Hyzer:

Reference is made to our letter of April 1, 1963 concerning the Local Flood Protection Project for the Saxonville area of the Town of Framingham.

In recent meetings with your representatives we have been informed that the project can no longer be studied under the authority of Section 205 of Public Law 87-874, owing to increased project costs in excess of the $1,000,000 Federal limitation.

We understand that Congressional action will now be required and that this will necessitate the preparation of a Survey Report.

We should, therefore, like to advise you that the Town's willingness to cooperate and financially participate in project improvements are currently the same as the attitudes expressed in our earlier letter.

Very truly yours,

Board of Selectmen

FWM:jlg

EXHIBIT NO. D-2

Town of Framingham

Massachusetts

Selectmen's Office

ELBERT TUTTLE, CHAIRMAN
WILLIAM D. OLESON, CLERK
THOMAS E. BARNICLE

April 1, 1963.

Colonel P. C. Hyzer, Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts.

Dear Colonel Hyzer:

We have examined the plan prepared by your office for flood protection in the Saxonville area of the Town of Framingham, as shown on drawing No. MER-1-1484 and concur in general with this plan.

In our opinion, if and when the project is authorized and funds are allotted for its construction, the Town of Framingham will meet the prescribed requirements of local cooperation and will agree to:

(1) Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for the construction of the project (presently estimated at $86,000);

(2) Hold and save the United States free from damages due to the construction works;

(3) Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army (presently estimated to cost $3,000 per year);

(4) Provide assurances that encroachment on improved channels will not be permitted; and

(5) Provide, without cost to the United States, all necessary modifications to existing utilities (presently estimated to cost $4,000).

Very truly yours,

Elbert Tuttle

William D. Oleson

Thomas E. Barnicle

ET/abb

BOARD OF SELECTMEN

EXHIBIT NO. D-3

PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
Region I
120 Boylston Street
Boston, Massachusetts 02116

December 30, 1964

Mr. John Wm. Leslie
Chief, Engineering Division
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Mr. Leslie:

This is in reference to your letter of December 16, 1964, regarding a local flood protection project along the Sudbury River in the Saxonville section of the Town of Framingham, Massachusetts.

The proposed project should have no adverse effect on pollution control in the area. It is recommended, however, that during the construction period care be exercised in any necessary sewer or force main relocations to avoid accidental spillages or discharges to the river.

Sincerely yours,

Thomas C. McMahon

Thomas C. McMahon, Chief
Water Resources Development Section
Water Supply and Pollution Control
Public Health Service

cc: W. H. Taylor

EXHIBIT NO. D-4

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
29 Cottage Street
Amherst, Massachusetts 01002

March 16, 1964

Mr. John William Leslie
Chief, Engineering Division
U. S. Army Engineering Division, New England
Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Mr. Leslie:

The Saxonville Local Protection Project on the Sudbury River in Framingham, Massachusetts, has been reviewed. Any recommended works by the Soil Conservation Service above Saxonville will have little or no effect on flood heights in the area being considered.

I find that this proposed project would be very compatible to the SuAsCo Watershed project. The installation of the proposed works will certainly alleviate a serious flooding problem.

Sincerely yours,

Benjamin Isgur
State Conservationist

1862 DEPARTMENT OF AGRICULTURE 1962
...wth Through Agricultural Progress

EXHIBIT NO. D-5

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 Temple Place
Boston 11, Massachusetts

May 22, 1962

Division Engineer
New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Sir:

This letter constitutes our conservation and development report on the fish and wildlife aspects of your local protection project at Saxonville, Massachusetts, on the Sudbury River. It was prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.), in cooperation with the Massachusetts Division of Fisheries and Game. The report has the concurrence of that agency as indicated in its letter dated May 18, 1962.

It is our understanding that the project will consist of diking and channel work around a portion of Saxonville, mainly to protect an industrial area.

It has been determined that this project will have no effect on the fish and wildlife resources nor are there any enhancement possibilities.

We contemplate no further studies on this project.

Sincerely yours,

M. A. Marston

M. A. Marston
Acting Regional Director

The Commonwealth of Massachusetts

Division of Fisheries and Game

73 Tremont Street, Boston 8

May 18, 1962

Mr. Earl T. Walker
U. S. Fish and Wildlife Service
59 Temple Place
Boston, Massachusetts.

Dear Mr. Walker:

In reference to your correspondence of May 16, relative to the conservation and development reports on the local protection projects at Millville on the Blackstone River and Saxenville on the Sudbury River, the Division of Fisheries and Game concurs with your evaluation of these projects.

Thank you for the opportunity to review and comment on the reports.

Very truly yours

Charles L. McLaughlin

Charles L. McLaughlin
Director

CLM:d

ATTACHMENT

REPORT ON SAXONVILLE LOCAL PROTECTION
SUDBURY RIVER
FRAMINGHAM, MASSACHUSETTS

Information Called for by
Senate Resolution 148, 85th Congress
Adopted 28 January 1958

REPORT ON SAXONVILLE LOCAL PROTECTION
SUDBURY RIVER
FRAMINGHAM, MASSACHUSETTS

Additional Information on Recommended and Alternative Projects Called for by Senate Resolution 148, 85th Congress - Adopted 28 January 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

The recommended project would be located along the left bank of the Sudbury River in the Saxonville section of Framingham, Massachusetts. The project would protect a developed area within the U-shaped bend of the Sudbury River extending from the Saxonville Pond Dam at Central Street to the Danforth Street Bridge, and would consist of channel relocation and improvement, levees and floodwalls, and pumping plant. Alternative methods of protection were given preliminary study, but found to be economically unjustified. The assumed project life for economic evaluation for all studied plans is 50 years.

Complete descriptions of the recommended plan and the alternative methods studied are given in Section IX of the main report and in Appendix C. The proposed project is shown on plates appended to Appendix C.

2. PROJECT COSTS

Project costs are based on average bid prices for similar work in the same general area adjusted to 1964 levels. Annual charges in the report are based on interest on the investment and amortization over the 50-year assumed project life to which are added amounts for maintenance and operation of the project and interim replacement of equipment having an estimated life of less than 50 years and loss of productivity of land. Interest rates are 3-1/8 percent for Federal and non-Federal costs. First costs and annual charges are detailed in Appendix C. Table 1, at the end of this supplement, shows a comparison of first costs and annual charges for the recommended project based on 50 and 100-year economic lives.

3. PROJECT BENEFITS

Estimates of recurring losses in the Saxonville area are predicated on an increasing land use and rising land values. Growth within the flood area would increase the recurring loss during the economic life of the project. Therefore, the average annual flood damage prevention benefits are computed for the economic life of both 50 and 100 years.

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Intangible benefits would accrue since the project would provide for an atmosphere of greater stability and confidence in the productive area which it would protect. Threats of disease, emergency evacuation measures and much of the threat to life posed by severe flooding would be virtually eliminated.

4. BENEFIT-COST RATIOS

Benefit-Cost ratios for the recommended project based on 50 and 100-year economic lives, are shown on Table 1.

5. PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR FUTURE NEEDS

The recommended project would provide protection for an area of undeveloped and flood-prone land on which the present owners plan to construct a building for industrial use. The project would also provide protection for existing residential, commercial, and industrial buildings which would undoubtedly be utilized to a higher degree if protected. In this respect, the plan takes into account the future needs of the area by making available needed industrial and commercial space and facilities.

6. ALLOCATION OF COSTS

The recommended project is for flood control only and, therefore, no allocations of costs among project purposes are required.

7. EXTENT OF INTEREST IN PROJECT

Officials of the Town of Framingham have evidenced intense interest in flood protection for Saxonville and have indicated that the Town would be willing and able to provide the necessary measures of local cooperation. The Massachusetts Water Resources Commission has also concurred in the recommended project. Firm assurances of local participation will be obtained after authorization, but prior to initiation of construction. Estimated costs to Federal and local interests are given in Table 1.

8. REPAYMENT SCHEDULES

There are no reimbursable functions incorporated in any of the studied projects.

9. EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS

The project will have little adverse effect on present State and local governmental services since the areas to be protected are already largely served by existing utilities, sewers, police and fire protection, schools and other public services. Anticipated construction in the area for industrial and commercial purposes will not appreciably increase the need for such services.

Tax revenues should increase, upon construction of the project, as a result of increased values of properties no longer subject to flooding and new construction in the now flood-prone areas afforded protection. The loss of taxes on land required for project purposes is considered to be negligible and will undoubtedly be more than offset by higher valuations on property afforded protection.

10. PROPOSED INCREASES IN APPROPRIATIONS

The recommended project would increase the Federal appropriations required for construction of flood control projects in the Merrimack River Basin by $1,300,000.

With approval of the project recommended in this report, the basinwide flood control plan for the Merrimack River together with the status of each element will be as in the following table:

Projects	Present Status
Dams and Reservoirs	
Blackwater	Completed
Edward MacDowell	Completed
Franklin Falls	Completed
Hopkinton-Everett	Completed
Mountain Brook	Inactive
Local Protection	
Fitchburg, Massachusetts	Completed
Haverhill, Massachusetts	Completed
North Andover & Lawrence, Massachusetts	Inactive
Lowell, Massachusetts	Completed
Nashua, New Hampshire	Completed
Lincoln, New Hampshire	Completed

TABLE 1

COST ANALYSIS - 50-YEAR AND 100-YEAR LIFE

(1964 Price Level)

Item	50-Year Life	100-Year Life
First Cost		
Federal	$1,300,000	$1,300,000
Non-Federal	190,000	190,000
TOTAL FIRST COST	$1,490,000	$1,490,000
Annual Charges		
Federal		
Interest	$ 40,600	$ 40,600
Amortization	11,100	2,000
Total Federal	$ 51,700	$ 42,600
Non-Federal		
Interest	$ 5,900	$ 5,900
Amortization	1,600	300
Maintenance & Operation	2,500	2,500
Interim Replacements	1,500	1,700
Loss of Productivity of Land	1,500	1,500
Total Non-Federal	$ 13,000	$ 11,900
TOTAL ANNUAL CHARGES	$ 64,700	$ 54,500
Annual Benefits	$ 73,300	$ 73,300
Benefit-Cost Ratio	1.1:1	1.3:1

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